Chapter Annex

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Annex 1

Annex 1-1 Comparative Assessment: Major Water-Related Environmental Problems (2000 vs 2025)

The Cambodia National TDA (2000) identified seven principal water-related environmental problem areas across freshwater and marine/coastal systems (UNEP/EAS/RCU, 1998). Twenty-five years later, these problem clusters remain but have generally intensified or shifted as rapid economic growth, urbanisation, coastal development and climate change have increased pressures on water quality, ecosystems and livelihoods (ADB, 2023; PEAMSAE & MoE, 2019; World Bank, 2023). Table 1-1 provides a strict analytical comparison between the 2000 baseline and updated 2025 evidence taken from recent national assessments and sector reports on socioeconomics, pollution, ecosystems, fisheries and disaster risk (ADB, 2023; Derrick et al., 2020; FiA, 2024; PEAMSAE & MoE, 2019; UNDP & NCDM, 2023; World Bank, 2023).

The comparative assessment shows that Cambodia's core water-related environmental problems have not only persisted since 2000 but, in most cases, have intensified substantially. Pollution pressures have risen sharply as coastal cities and special economic zones expanded faster than wastewater and solid-waste infrastructure. Centralised treatment plants still handle only a small proportion of total sewage—less than 20% in Preah Sihanouk, under 10% in Kampot and almost none in Koh Kong and Kep—while most households rely on septic systems that frequently overflow into drains and canals (ADB, 2023; WEPA, 2020). Coastal and estuarine monitoring consistently reports high faecal-coliform loads (10^4–10^5 CFU/100 mL) and elevated nitrate and phosphate concentrations, while industrial effluents near ports and SEZs often exceed national standards for oil and grease, total petroleum hydrocarbons, lead and zinc (ADB, 2023; MoE, 2013; WEPA, 2020).

Fisheries indicators reveal long-term, systemic depletion. Demersal trawl CPUE has collapsed from about 173 kg/hour in the 1960s to roughly 26 kg/hour today (FiA, 2024), and reconstructed catch series show strong declines in higher-trophic species and increasing dominance of small pelagics (Derrick et al., 2020). Sharks and rays have fallen from thousands of tonnes in the early 2000s to very small residual landings, while trawls and purse seines together account for the vast majority of marine catches, confirming intense gear-driven pressure on coastal stocks (Derrick et al., 2020; FiA, 2024).

Freshwater and estuarine wetlands remain central to rural livelihoods but are increasingly stressed by land-use change, hydrological alteration and salinity intrusion. Peat-forming mangrove–wetland mosaics in Koh Kong and floodplain systems linked to the Mekong–Tonle Sap–Bassac complex are particularly sensitive to drainage, new roads and channel infilling (PEAMSAE & MoE, 2019; SCSSAP, 2020). Socio-economic studies at Koh Kapik–Peam Krasop and associated Ramsar sites show that 65–90% of household income can derive from wetland-based fisheries and natural resources, highlighting the vulnerability of these communities to further habitat loss or hydrological disruption (Fauna & Flora, 2024; Ramsar Secretariat, 2012).

Updated habitat mapping indicates that mangrove extent has declined by around 3,500–4,000 ha between 2014 and 2025, with the largest losses in Koh Kong and peri-urban fringes of Preah Sihanouk (PEAMSAE & MoE, 2019; SCSSAP, 2020). Coral cover at many nearshore sites has dropped to 6–10%, while seagrass meadows—especially in the Kampot–Kep area—have shrunk by roughly 20% under pressure from trawling, dredging, reclamation and turbidity (ADB, 2023; MoE, 2013). These ecosystem losses reduce fisheries productivity, carbon storage and natural coastal protection.

Hydrological extremes have also become more severe. Floods remain Cambodia's most damaging hazard, with exposure highest along the Mekong–Tonle Sap–Bassac corridor and coastal lowlands (UNDP & NCDM, 2023; World Bank, 2023). Climate projections point to more intense rainfall events and higher flood peaks, while observed salinity intrusion is advancing 5–7 km inland in some estuaries (World Bank, 2023). Droughts are intensifying under ENSO variability and rising temperatures; recent events have affected millions of people, and many agricultural and peri-urban areas now experience recurrent water shortages, groundwater stress and higher aquaculture mortality during prolonged dry periods and heatwaves (FiA, 2024; UNDP & NCDM, 2023; World Bank, 2023).

River-borne pollution remains a defining feature of coastal water quality. Monitoring along the Mekong–Tonle Sap–Bassac system shows persistent exceedance of faecal-coliform standards and repeated TN/TP exceedances at key confluence points, with TSS reaching over 2,000 mg/L in parts of the Bassac during high-flow conditions (MoE, 2013; WEPA, 2020). These loads generate large sediment and nutrient plumes that affect estuaries such as Kampot Bay and Koh Kong and contribute to cross-border nutrient export to the Viet Nam delta and the wider Gulf of Thailand (ADB, 2023; SCSSAP, 2020). Overall, the updated evidence confirms that the conditions diagnosed in 2000 have not improved; instead, pressures have multiplied and intensified, calling for urgent, integrated responses across wastewater management, fisheries reform, habitat conservation, climate-resilient planning and catchment-to-coast governance.

Annex Table 1-1 Comparative analysis of major water-related environmental problems (2000 vs 2025)

Problem Category (2000)	**Status / Evidence in 2000 (Baseline)**	**Status / Evidence in 2025**	**Key Sources**
1. Contamination of water quality – domestic & non-point pollution	Widespread organic pollution and domestic sewage from urban centres, with almost no wastewater treatment systems in coastal provinces. Monitoring already reported elevated BOD and TSS in urban rivers and receiving waters, alongside growing inputs of fertilizers and pesticides from agriculture	Centralised plants still treat only a small fraction of total flows: <20% of sewage in Preah Sihanouk, <10% in Kampot, and almost none in Koh Kong and Kep, while most households rely on septic tanks that frequently overflow into drains and canals. FC levels in bathing waters and landing sites often reach 10^4–10^5 CFU/100 mL, and estuarine NO_3^- and PO_4^{3-} concentrations (2.0–2.6 mg/L and 0.7–0.8 mg/L) exceed ASEAN guideline values. Industrial discharges near ports and SEZs frequently surpass national limits for oil & grease, TPH, Pb and Zn, creating toxic hotspots in nearshore sediments.	MoE (2023); ADB (2023)

	and upland catchments.		
Overfishing and declining fish stocks (freshwater & marine)	Early evidence of declining catches in Tonle Sap and coastal zones, with widespread use of destructive gears and limited enforcement. Stock assessments were sparse, but concerns were raised over reduced average fish size and loss of higher-value species.	Long-term indicators now show systemic depletion: demersal trawl CPUE has collapsed from 173 kg/hr in the 1960s to about 26 kg/hr today; ecosystem indices (MTI, FiB, PPR) indicate fishing further down the food web; and sharks and rays have fallen from 2,000–4,000 t in the early 2000s to single-digit tonnes by 2018–2019. Small pelagics now account for more than 70% of marine catch, while trawls and purse seines generate 85–90% of landings, confirming intense, gear-driven pressure on coastal stocks.	FiA (2025); SAU (2024)
Habitat degradation – freshwater wetlands	Loss and degradation of wetlands due to agricultural expansion, drainage works and conversion for settlements and infrastructure, reducing the extent and quality of nursery grounds and flood-buffering functions.	Freshwater and estuarine wetlands remain central to rural livelihoods but are under increasing strain from land-use change, altered flow regimes and salinity intrusion. Peat-forming mangrove–wetland mosaics in Botum Sakor and floodplain systems linked to the Mekong–Tonle Sap–Bassac complex are highly sensitive to drainage, road construction and channel infill. In key sites such as Koh Kapik–Peam Krasop, more than 65–90% of household income depends on wetland-based fisheries and resources, making communities extremely vulnerable to any further habitat loss or hydrological disruption.	Ramsar (2012); MoE (2024)
Habitat degradation – mangroves, coral reefs, seagrasses	Coastal habitats were mapped and recognised as important, but protected-area coverage and enforcement were limited. Early signs of mangrove clearance, coral damage from destructive fishing and sedimentation, and poorly	Updated mapping shows mangroves declining from ~58,866 ha (2014) to ~55,355 ha (2025), a net loss of 3,510–4,000 ha, concentrated in Koh Kong and peri-urban Preah Sihanouk. Coral cover in many nearshore sites has fallen to 6–10%, with only "fair" condition (20–30% cover) on less-impacted offshore reefs, while seagrass meadows—especially in the Kampot–Kep corridor—have shrunk by about 20%,	MoE (2023); ADB (2023)

	understood seagrass distributions were noted.	mainly due to trawling, dredging, shoreline works and turbidity increases. These losses compromise fisheries productivity, blue-carbon storage and natural coastal protection.	
Flooding (freshwater) and hydrological variability	Floods and droughts were already significant hazards, with Tonle Sap flow reversals and monsoon variability shaping seasonal exposure; adaptive capacity and disaster-risk systems were limited.	Floods remain Cambodia's deadliest and most damaging natural hazard, with major events affecting large populations and infrastructure along the Mekong–Tonle Sap–Bassac and coastal plains. Recent assessments classify national disaster risk as "medium" with very high river-flood exposure; climate projections point to more intense rainfall events and higher flood peaks, while salinity intrusion is advancing 5–7 km inland in some estuaries, raising compound risks for agriculture, water supply and ecosystems.	NCDM & UNDP (2021); WB (2021)
Drought-related impacts (freshwater + agriculture)	Seasonal droughts periodically affected rice production and domestic water supply; water-storage and irrigation infrastructure were inadequate and unevenly distributed.	Drought has become more frequent and severe under ENSO variability and rising temperatures, with the 2016 event affecting around 2.5 million people. Agricultural zones and peri-urban communities experience recurrent water shortages; shallow aquifers and small reservoirs are increasingly stressed, while aquaculture faces higher mortality, greater disease incidence and rising input costs during prolonged dry periods and heatwaves.	WB (2021); FiA (2025)
Transboundary pollution & river–coast linkages	The Mekong–Tonle Sap–Bassac system was recognised as a major conduit for sediment, nutrients and pollutants, with high faecal-coliform levels in Phnom Penh discharge zones and significant loads delivered to	River-borne pollution remains a defining feature of Cambodia's coastal water quality. Monitoring at Phnom Penh and along the Bassac indicates persistent exceedance of FC standards and repeated TN/TP exceedances at confluence points; TSS can reach 2,030 mg/L in the Bassac during high-flow conditions. These loads feed large sediment and nutrient plumes that affect estuaries	MoE (2023); ADB (2023)

	the Vietnamese delta and coastal waters.	such as Kampot Bay and Koh Kong and contribute to cross-border nutrient export to the Viet Nam delta and the wider Gulf of Thailand.	

Annex 1-2 New or Intensifying Issues Not Assessed in 2000

New threats not explicitly considered in the 2000 TDA have become major national priorities. Climate change now acts as a system-wide risk amplifier, driving sea-level rise, salinity intrusion, extreme rainfall, urban flooding and marine heatwaves that undermine infrastructure, fisheries and ecosystems (World Bank, 2023; UNDP & NCDM, 2023). Projections indicate sea-level rise of 11–20 cm by 2050, with observed salinity intrusion extending 5–7 km inland and coral bleaching occurring during strong ENSO years (World Bank, 2023). Urban floods are worsening due to intense rainfall combined with undersized drainage networks.

Marine plastics and microplastics have become chronic pollutants. Cambodia now generates more than 730,000 t/year of plastic waste, with at least 14,000 t/year entering coastal environments; sediments at several hotspots contain 120–350 microplastic particles per kg (ADB, 2023). Floating debris is increasingly common near ports and tourism beaches, creating risks for marine life, food safety and public health.

Industrial and port-related pollution has intensified. Inspections show that around 60% of facilities near ports and SEZs are non-compliant with effluent standards, with high levels of oil and grease, total petroleum hydrocarbons, lead and zinc (ADB, 2023; MoE, 2013). Hazardous and medical waste generation—estimated at roughly 120,000 t/year for industry and up to 20 t/day during the COVID-19 period—continues to overwhelm available treatment capacity (MoE, 2013).

Rapid and often unplanned coastal urbanisation further strains environmental systems. Cambodia's urban population reached 39% in 2019, with Sihanoukville expanding fastest through large-scale land reclamation and real-estate growth (PEAMSAE & MoE, 2019). These changes have modified shorelines, reduced natural buffers and outpaced wastewater and drainage systems, increasing risks of flooding, erosion and pollution.

Aquaculture expansion contributes growing nutrient and microbial loads. National aquaculture output exceeded 330,000 tonnes in 2022, with marine farming increasingly intensive in areas such as Trapeang Ropov and Chroy Svay. Feed conversion ratios of 1.6–2.0 result in 25–30% feed loss to water, raising BOD and TSS, while studies have detected antibiotic-resistance genes in effluents, indicating emerging AMR risks (FiA, 2025).

Despite improved legal frameworks—such as the Code on Environment and Natural Resources and expanded MPA coverage—significant governance gaps remain. The NCCMD marine sub-decree is still pending, MSP has not been formalised, fewer than 30% of MPAs are effectively patrolled and operational budgets for enforcement remain limited (ADB, 2023; PEAMSAE & MoE, 2019). These constraints reduce the State's capacity to manage cumulative pressures from ports, fisheries and coastal development.

Finally, sedimentation and turbidity are rising due to land clearing, road construction, sand mining and coastal works. In Koh Kong, sediment inflows to estuaries have increased by more than 35%, while monsoon-season TSS in Kampot Bay can reach

250–320 mg/L (MoE, 2013; SCSSAP, 2020). High sediment loads reduce light penetration, stress corals and seagrasses and interact with nutrient enrichment to elevate eutrophication risks.

Together, these emerging threats demonstrate that Cambodia's coastal risks are increasingly complex, interconnected and climate-sensitive, necessitating stronger pollution control, climate-resilient planning, compliance systems and a fully operational marine spatial planning framework.

Annex Table 1-2 Emerging environmental issues (post-2000)

New or Emerging Issue (Post-2000)	**2000 Status**	**2025 Status**	**Key Sources**
Climate change impacts (SLR, salinity intrusion, marine heatwaves)	Climate change was not explicitly included as a separate diagnostic theme; sea-level rise and temperature change were not quantified in the 2000 national report.	Recent projections indicate sea-level rise of +11–20 cm by 2050, accompanied by higher sea-surface temperatures and more frequent marine heatwaves. Observed impacts include advancing salinity intrusion (5–7 km inland in some estuaries), greater coastal-flood depth and duration, and mass-bleaching episodes on coral reefs, particularly during strong ENSO years. Urban flooding is intensifying as extreme rainfall interacts with undersized drainage and high impervious-surface cover.	WB (2021)
Marine plastics & microplastics	Plastic waste and microplastics were not recorded as a distinct pollution category and received little or no attention in the 2000 analysis.	National plastic-waste generation now exceeds 730,000 t/year, with coastal leakage estimated at more than 14,000 t/year. Coastal sediments in some hotspots contain 120–350 microplastic particles/kg, and floating debris is commonly observed near ports, tourism beaches and river mouths. These trends pose chronic risks to marine life, fisheries, tourism and public health.	MoE (2023)
Industrial & port-related pollution	Industrial and port activities were mentioned only briefly, with limited data on effluent composition or spill risks.	Expansion of coastal SEZs and port infrastructure has created localised toxic hotspots. Recent inspections show about 60% of sampled facilities near ports/industrial zones are non-compliant with	ADB (2023)

		effluent standards, with elevated oil & grease, TPH, Pb and Zn. Hazardous and medical wastes (~120,000 t/year industrial; COVID-era medical peaks up to 20 t/day) strain limited treatment and disposal capacity, increasing the risk of accidental releases and chronic contamination.	
Urbanization pressure & land reclamation	Urbanisation levels were relatively low (~16% of the population in 1998), and large-scale coastal reclamation had not yet begun.	Urbanisation has accelerated sharply: Census data show the urban share rising to 39% by 2019, with especially rapid growth in Sihanoukville and other coastal towns. Extensive land reclamation and real-estate development in Preah Sihanouk and selected estuaries have altered shoreline configuration, reduced natural buffers and outpaced the capacity of drainage, wastewater and solid-waste systems, heightening exposure to floods, erosion and pollution.	NIS (2019)
Aquaculture nutrient/microbial loading	Aquaculture existed but at relatively small scale; nutrient and microbial loads from ponds and cages were not considered a major driver in the 2000 diagnosis.	Aquaculture has expanded dramatically, with national production reaching over 330,000 t in 2022. Marine/coastal farming remains a smaller share but is locally intense: feed conversion ratios of 1.6–2.0 imply that 25–30% of feed is lost as waste, elevating BOD and TSS in dense farming zones such as Trapeang Ropov and Chroy Svay. Studies detect antibiotic-resistance genes in farm effluents, signalling emerging AMR risks alongside disease outbreaks and periodic mass mortality events.	FiA (2025)
Governance gaps in enforcement & MSP	The 2000 report noted fragmented mandates and limited capacity but did not	Today, Cambodia has a more complete legal and institutional framework (Code on Environment & Natural Resources, Fisheries Law,	MoE (2024)

	systematically assess governance performance, ICZM or MSP.	PAs, IWRM commitments, NCCMD/NCSD), but significant gaps remain at sea. The NCCMD marine sub-decree is still pending, leaving offshore zoning and MSP without a clear legal backbone; MPA coverage has increased but less than 30% of marine protected areas are effectively patrolled; and patrol, prosecution and O&M budgets remain thin. These factors limit the ability of institutions to reverse ecosystem degradation and manage cumulative impacts from ports, tourism and fisheries.	
Sedimentation / turbidity from land-use change	Sediment and turbidity issues were recognised but not quantified; monitoring was limited to a few stations and data on land-use drivers were sparse.	Land clearing, road construction, sand mining and coastal works have increased sediment yields. In Koh Kong, land-cover change and infrastructure expansion are estimated to have raised sediment inflows to estuaries by more than 35%, while TSS in some monsoon-affected estuaries (e.g. Kampot Bay) can exceed 250–320 mg/L. These high loads reduce light penetration, stress corals and seagrasses, and interact with nutrient enrichment to increase the risk of eutrophication and habitat loss.	MoE (2023)

Annex 1-3 Subnational Geographic Divisions

Annex Table 1-3 Geographic divisions used in the analysis

Division	Description	Application
Coastal provinces	Koh Kong, Preah Sihanouk, Kampot, Kep	Socioeconomics, climate risk, governance.
River basins	Mekong–Tonle Sap–Bassac; Tatai; Kah Bpow; Prek Thnot	Pollution and sediment pathways.

Marine subregions	Sihanoukville coast; Kampot–Kep corridor; Koh Kong estuaries; Koh Rong archipelago	Ecosystem, fisheries, pollution and development dynamics.

Annex 1-4 Indicator Inventory

Annex Table 1-4 Indicators used by component

Component	Indicator group	Primary sources
Socioeconomics	Population, HDI/SHDI, poverty, livelihoods, urbanisation, disaster impacts	NIS; UNDP; MOP
Pollution	TN, TP, FC, TSS, COD, BOD, TPH, metals; plastics; hazardous waste	MoE; WEPA; ADB
Ecosystems	Mangrove extent, coral cover, seagrass, wetland condition, species lists	MoE; PEMSEA; Ramsar
Fisheries	CPUE, MTI, FiB, species trends, gear impacts, aquaculture	FiA; SAU
Governance	ICZM, MSP readiness, MPAs/MFMAs, patrol effort, budgets, legal instruments	MoE; NCSD; FiA

Annex 1-5 Expanded Risk-Assessment Methods

This annex describes the technical approach used to derive risk levels for ecosystems, people and livelihoods across Cambodia's coastal and river–sea interface zones. The method follows the **Exposure–Sensitivity–Adaptive Capacity (ESAC)** framework widely applied in climate and environmental risk assessments, and is harmonised with **UNEP/GEF TDA–SAP guidelines** and regional indicator templates.

1. Exposure Indicators

Exposure represents the **degree to which ecosystems or communities are subject to hazards**. Indicators capture the intensity, frequency and spatial distribution of biophysical pressures.

Pollution loads:

- Total Nitrogen (TN), Total Phosphorus (TP)
- Fecal coliform (FC) levels
- Chemical pollutants (oil & grease, TPH, Pb, Zn)
- Microplastics (density in sediments and water column)
- These highlight areas receiving untreated wastewater, industrial discharges or solid-waste leakage

Fishing pressure

- Spatial distribution of trawl and purse-seine effort
- Gear intensity in inshore zones (<20 m depth)
- Reconstructed effort trends from FiA and SAU
- These indicators identify areas of chronic ecosystem stress and habitat disturbance.

Climate hazards:

- Flood frequency, magnitude and affected population
- Drought intensity (ENSO-linked) and duration
- Sea-level rise (SLR) projections
- Marine heatwaves and temperature anomalies
- These are used to characterise hazard “hot years” and long-term climatic shifts.

Coastal development intensity:

- SEZ footprint and density
- Port expansion, dredging and reclamation areas
- Tourism and urbanisation rates
- High development intensity correlates with pollution hotspots, habitat loss and erosion.

River discharge and sediment inflows:

- Discharge peaks (Mekong–Tonle Sap–Bassac system)
- Total Suspended Solids (TSS) in monsoon flows
- This explain transboundary nutrient and sediment delivery to estuaries and coastal waters.

2. Sensitivity Indicators

Sensitivity captures the degree of harm that ecosystems or communities are likely to experience when exposed to a hazard**.**

Coral bleaching susceptibility

- Presence of bleaching events during heatwaves
- Coral genera with low thermal tolerance
- Sediment-tolerant vs. sensitive assemblages

Seagrass turbidity thresholds

- Light-limitation thresholds (e.g., TSS > 25–30 mg/L)
- Species-specific responses to sedimentation
- Nearshore dredging impacts

Mangrove fragmentation and dieback

- Patch-size metrics
- Proportion of degraded vs. intact stands
- Proximity to hydrological blockages and conversion areas

Livelihood dependence

- Share of income from fisheries, wetlands and coastal resources
- Proportion of households dependent on daily catch or gleaning
- High dependence increases vulnerability to ecological shocks.

Poverty incidence and vulnerable groups

- IDPoor distribution
- Exposure of low-income groups to floods, salinity intrusion or pollution
- Poorer households have limited resources to cope and recover.

3. Adaptive Capacity Indicators

Adaptive capacity reflects **the ability of institutions, communities and ecosystems to moderate damage or adjust to change**.

Enforcement and patrol capacity

- Number of patrol days per month
- Functionality of MFMA/MPA enforcement teams
- Inter-agency coordination levels

Existence and implementation of ICZM/MSP

- Legal instruments enabling coastal zoning
- Institutional mandates and clarity
- Degree of MSP operationalisation (planning, mapping, zoning)

Wastewater and pollution-control infrastructure

- WWTP capacity and coverage
- Industrial compliance monitoring
- Availability of landfills, transfer stations and hazardous-waste handling

Social protection and livelihood diversification

- Access to IDPoor, cash transfers, microfinance
- Availability of alternative jobs in tourism, aquaculture or services
- Communities with diversified livelihoods are less vulnerable.

Community organisation and co-management

- Strength of Community Fisheries (CFis) and Protected Area (CPA) committees
- NGO partnership presence
- Participation in monitoring or resource management
- Stronger social capital tends to reduce risk.

4. Scoring Approach (ESAC Model)

A standardised scoring system is applied for comparability across provinces and seascapes.

Scoring scale

- **Exposure:** 1 (low) – 3 (high)
- **Sensitivity:** 1 (low) – 3 (high)
- **Adaptive Capacity:** 1 (strong) – 3 (weak)

Risk formula

$$Risk = \frac{\text{Exposure x Sensitivity}}{\text{Adaptive Capacity}}$$

Interpretation of results

Final Risk Score	Interpretation	Implication
< 2.0	**Low**	Ecosystems/communities can cope; targeted interventions still beneficial.
2.0 – 3.0	**Moderate**	Evidence of increasing pressure; requires monitoring and preventive actions.
> 3.0	**High**	Acute or chronic risk; urgent management, investment and regulatory action needed.

Spatial comparison

Risk scores are mapped at:

- **Provincial scale** → governance and socioeconomic patterns
- **Ecosystem scale** → mangrove stands, seagrass beds, coral reefs
- **Marine subregion scale** → Sihanoukville, Kampot–Kep, Koh Kong, Koh Rong

This allows identification of persistent hotspots such as:

- Peam Krasop–Koh Kapik
- Sihanoukville urban–industrial coastline
- Kampot–Kep seagrass corridor
- Phnom Penh river–sea discharge interface

Annex 1-6 Supplementary Notes (Supporting Materials)

1. Definitions and Terminology

This section provides standardized definitions used throughout Chapter 1 and subsequent chapters to ensure consistency with UNEP/GEF TDA–SAP methodology and regional SCS–GOT practice.

Coastal zone

Defined as Cambodia’s four first-level administrative coastal provinces—Koh Kong, Preah Sihanouk, Kampot and Kep—together with associated **river mouths, estuaries, tidal-influence zones and nearshore islands**. This aligns with regional coastal delineation under PEMSEA and the SCS–SAP.

Estuarine–marine interface

Areas within which **freshwater discharge strongly influences salinity, nutrient dynamics, sedimentation patterns, turbidity and ecological structure**. These interfaces are critical for nurseries, fisheries recruitment and pollutant delivery from land to sea.

Pressures vs. drivers

- **Pressures** refer to *direct, measurable human activities* that affect environmental conditions (e.g. industrial effluent, trawling, dredging, land reclamation, aquaculture effluent).
- **Drivers** are *underlying socioeconomic forces*—urbanisation, demographic growth, market demand, port/tourism development, agricultural expansion—that shape the magnitude and direction of pressures.

Risk terminology

- **Exposure** = presence/intensity of hazards.
- **Sensitivity** = susceptibility of ecosystems/communities to harm.
- **Adaptive Capacity** = ability to respond, cope or recover from impacts. These follow IPCC and UNEP/GEF formulations.

2. Data Treatment Notes

These notes document how data were cleaned, normalised and interpreted for the risk assessment and comparative analysis in Chapter 1.

Pollution datasets

- When multiple readings are available, the **90th percentile** is used to represent “worst-case” values—consistent with health protection thresholds.
- For provinces with limited sampling frequency, **monsoon-season maxima** were used to ensure conservative estimation of risk.
- Industrial effluent data were included only if directly cited in MoE inspections or ADB environmental monitoring reports.

Ecosystem condition datasets

- **Coral cover categories** follow international thresholds:
    - *Poor:* 0–10%
    - *Fair:* 10–30%
    - *Good:* 30–50%
    - *Very good:* >50%
- Seagrass diversity benchmarks are anchored to the **regional maximum of 11 species** across mainland Southeast Asia.
- Mangrove data follow MoE/PEMSEA classifications (Landsat-based, 30 m resolution), with 2014 as the harmonised baseline.

Socioeconomic and fisheries datasets

- FiA datasets were cross-checked with reconstructed catch series from **Sea Around Us (SAU)** for consistency.
- Poverty data use **IDPoor (MoP)** and **UNDP SHDI/IHDI** for comparative vulnerability scoring.
- CPUE was normalised where gear-effort reporting changed over time.

3. Notes on Alignment with Regional TDA–SAP Process

Alignment of indicator sets

All indicators used in Chapter 1 correspond to the **four regional SCS–SAP component groups**:

1. Pollution
2. Habitats & Biodiversity
3. Fisheries
4. Governance

Consistency with regional transboundary hotspots

Cambodia's national-level risk hotspots correspond directly with **priority transboundary areas identified in the original SCS–SAP and its 2020 update**:

- **Koh Kong–Trat mangrove complex** (Cambodia–Thailand)
- **Kampot–Kep–Ha Tien seagrass corridor** (Cambodia–Viet Nam)
- **Sihanoukville–Phu Quoc development corridor** (Cambodia–Viet Nam)

These areas show strong ecological connectivity, shared fisheries stocks, and cross-border pollution/marine debris movement.

Governance criteria alignment

The governance assessment applies the **SAP governance criteria**:

- *Clarity* of mandates
- *Coherence* across institutions
- *Capacity* for implementation
- *Compliance* and enforcement
- *Coordination* between agencies and local authorities

These criteria guide the identification of governance gaps and priority reforms.

4. Notes on Causal Chain Analysis (CCA)

CCA in Chapter 1 follows standard UNEP/GEF TDA guidance: establishing relationships from *root causes* → *drivers* → *pressures* → *state change* → *impacts* → *governance responses*.

Pollution CCA

- **Root causes:** weak wastewater and industrial oversight; rapid urbanisation; insufficient financing; lack of monitoring.
- **Drivers:** SEZ expansion, tourism, population growth, urban development.
- **Pressures:** untreated sewage, industrial effluent, solid waste leakage, agricultural runoff.
- **State changes:** elevated FC, TN/TP, metals, TSS; algal blooms; habitat stress.
- **Impacts:** reduced fisheries productivity, ecosystem degradation, public-health risks.
- **Responses:** wastewater investment, standards enforcement, coastal zoning.

Fisheries CCA

- **Root causes:** open access; limited patrol budgets; inadequate licensing/effort control.
- **Drivers:** market demand, poverty, urban fish consumption, export.
- **Pressures:** destructive gears, excessive trawling, illegal fishing.
- **State changes:** declining CPUE, trophic shift, habitat damage.
- **Impacts:** reduced livelihoods, food security risks.
- **Responses:** MFMA, MPA expansion, patrol strengthening, value-chain reforms.

Climate CCA

- **Root causes:** global greenhouse-gas emissions; ENSO amplification.
- **Drivers:** coastal land-use changes, urbanization, loss of buffers.
- **Pressures:** SLR, storm surges, extreme temperatures, hydrological extremes.
- **State changes:** salinity intrusion, coral bleaching, drought, extreme flooding.
- **Impacts:** infrastructure damage, loss of agricultural productivity, ecosystem stress.
- **Responses:** adaptation planning, climate-resilient infrastructure, EWS, buffer restoration.

5. Cross-Cutting Themes

5.1 Blue Carbon

Mangroves and seagrass systems play a critical role in **carbon sequestration**, coastal protection and climate adaptation.

- Mangroves store **4–10 times more carbon** per hectare than upland forests.
- Seagrass meadows stabilise sediments, absorb nutrients and support marine megafauna (dugongs, turtles).

These systems are emphasised in national climate strategies and the Kunming–Montreal Global Biodiversity Framework (30x30).

5.2 Gender and Livelihoods

Gender analysis highlights:

- Women's roles in post-harvest processing, gleaning and small-scale aquaculture.
- Women's vulnerability to climate shocks and ecosystem degradation due to livelihood dependence and lower asset ownership.
- Where data permit, gender dimensions are incorporated into vulnerability scoring.

5.3 Transboundary Linkages

Cambodia's coastal systems are hydrologically and ecologically connected to the wider **Gulf of Thailand and Mekong Basin**:

- Riverine discharge from the **Tonle Sap–Bassac–Mekong** shapes nutrient and sediment regimes.
- Seasonal currents transport marine debris, microplastics and sometimes oil slicks.

- Shared fisheries stocks (anchovies, small pelagics, blue swimming crabs) require coordinated management across Cambodia, Viet Nam and Thailand.

Annex 2

Annex 2-1 Dataset and analysis framework, and complimentary note

A. Demographic indicator

Demographic indicators describe the size, structure and spatial distribution of the population in Cambodia and its four coastal provinces. Core variables include total population, number of households, sex ratio, age structure, and population density, as well as the share of people living in urban areas and major coastal settlements. Data are drawn primarily from the 1998, 2008 and 2019 Population Censuses and official intercensal projections. Indicators are computed at national and provincial level; coastal totals are obtained by summing the four coastal provinces and, where relevant, expressing them as a share of national population. Where different classifications or boundary changes occur, the annex notes how these have been harmonised across time. Provincial-level time-series remain discontinuous—therefore comparisons rely on harmonised census rounds rather than annual estimates. Coastal totals are derived through straightforward aggregation of the four coastal provinces.

Annex Table 2-1 Demographics indicators: data sources, metadata, & assessment methods

Indicator	Definition & Unit	Spatial Coverage	Time Series Availability	Primary Data Sources	Method / Notes
Total population	Number of people (persons)	National; 4 coastal provinces	Census years: **1998, 2008, 2019**; projections 2020–2030	NIS Population Census; UN WPP projections	Coastal total = sum of 4 coastal provinces. No adjustments except boundary harmonization.
Number of households	Total households (HH)	National; coastal provinces	1998, 2008, 2019	NIS Census	Used to derive average household size; no interpolation.
Population density	Persons per km²	National; provincial	1998–2019	NIS; Administrative boundary area data	Density = population ÷ land area. Coastal mean is population-weighted.
Urbanization rate	% population in urban areas	National (1990–2035); coastal	National (annual WUP); coastal	UN DESA World Urbanization	1975–79 values excluded due to data

		(1998–2019)	(census years only)	Prospects (WUP); NIS	disruption. No extrapolation for provinces.
Sex ratio	Males per 100 females	National; provincial	1998, 2008, 2019	NIS Census	Reported directly; no adjustments.

Annex Table 2-2 Subnational Coastal Populations (1998, 2008, & 2019)

Pop. Census 1998	Persons	Females	Males	Households
Preah Sihanouk	155,690	78,750	76,940	28,015
Koh Kong	132,106	64,406	67,700	24,960
Kampot	528,405	275,320	253,085	104,993
Kep	28,660	14,646	14,014	5369
Coastal (total)	844,861	433,122	411,739	163,337
Pop. Census 2008	**Persons**	**Females**	**Males**	**Households**
Preah Sihanouk	221,396	110,619	110,777	45,237
Koh Kong	117,481	58,154	59,327	24,311
Kampot	585,850	301,727	284,123	130,084
Kep	35,753	18,079	17,674	7,236
Coastal (total)	960,480	488,579	471,901	206,868
Pop. Census 2019	**Persons**	**Females**	**Males**	**Households**
Preah Sihanouk	310,072	148,610	161,462	47,381
Koh Kong	125,902	62,458	63,444	28,027
Kampot	593,829	306,239	287,590	143,402
Kep	42,665	21,601	21,064	9,605
Coastal (total)	1,072,468	538,908	533,560	228,415

Source: NIE, General Population Census of Cambodia (1998, 2008, 2019)

Annex Table 2-3 Subnational Coastal Demographic indicators/data (1998, 2008, & 2019)

Areas of subnational Coastal region (km^2)	2019		
Coastal area	17,237		
Preah Sihanouk	1,938		
Koh Kong	10,090		
Kampot	4,873		
Kep	336		
Subnational coastal populations as % of national population	**1998**	**2008**	**2019**
Coastal area	7.30	7.20	6.90
Preah Sihanouk	1.50	1.70	2.00
Koh Kong	1.01	0.90	0.80
Kampot	4.62	4.40	3.80
Kep	0.25	0.30	0.30

Subnational Coastal region areas as % of national area	2019	
Coastal area	9.52	
Preah Sihanouk	1.07	
Koh Kong	5.57	
Kampot	2.69	
Kep	0.19	
Annual Subnational Coastal region population changes (%)	**1998-2008**	**2008-2019**
Coastal area	0.80	1.00
Preah Sihanouk	2.54	3.10
Koh Kong	0.12	0.60
Kampot	1.03	0.10
Kep	2.21	1.60

Coastal population densities (person/km^2)	1998	2008	2019
Coastal area	49	56	62
Preah Sihanouk	89	114	160
Koh Kong	12	12	12
Kampot	108	120	122
Kep	85	106	127
% of national population in rural and urban areas (%)	**1998**	**2008**	**2019**
Urban	15.7	19.51	39.45
Rural	84.3	80.49	60.55

Source: NIE, General Population Census of Cambodia (1998, 2008, 2019)

B. Human wellbeing indicators

Human wellbeing indicators capture longer-term development trends and distributional outcomes. The annex reports national and subnational Human Development Index (HDI/SHDI), inequality-adjusted HDI (IHDI), multidimensional poverty (MPI), and income/consumption-based poverty measures, together with selected social indicators (education, health, social protection coverage) where available. HDI and IHDI are taken from UNDP Human Development Reports, SHDI from Global Data Lab, and monetary poverty from World Bank and national poverty assessments, complemented by IDPoor targeting data. Methods focus on comparing coastal provinces with national averages, highlighting gaps or penalties (e.g. the IHDI "loss" due to inequality) and how these have evolved over time.

Annex Table 2-4 Human wellbeing indicators: data sources, metadata, & assessment methods

Indicator	Definition & Unit	Spatial Coverage	Time Series Availability	Primary Data Sources	Computation / Notes

HDI (Human Development Index)	Index (0–1)	National	**1990–2023** (annual)	UNDP HDR Statistical Annex 2023/24	Standard HDR methodology; no recalculations.
IHDI (Inequality-adjusted HDI)	Adjusted index & % "loss"	National	Latest available year	UNDP HDR	IHDI penalty = (HDI−IHDI)/HDI.
SHDI (Subnational Human Development Index)	Index (0–1)	Provincial	Latest available year (typically 2019–2022)	Global Data Lab	Used to compare coastal vs. non-coastal gaps; static (no historical series).
Monetary poverty (national poverty line)	% of people/HH below line	National & provincial	Various rounds: **2007, 2009, 2012, 2014, 2019–2020**	World Bank; IDPoor; MoP	Poverty lines changed across rounds; breakpoints documented in notes.
Multidimensional Poverty Index (MPI)	% poor; intensity of deprivation	National; regions	Latest MPI release (2023/24)	OPHI & UNDP	Not comparable across years; interpret as cross-section.
Social protection coverage	% of HH benefiting from IDPoor, cash transfers or health insurance	National; coastal if available	2019–2024 (irregular)	IDPoor; MEF; MoSVY	Used as qualitative adaptive-capacity indicator.
Education/Health basic indicators	Literacy; school attendance; child survival	National; provincial where available	Census years + select DHS years	NIS; DHS	Limited coastal disaggregation; used qualitatively.

Annex Table 2-5 Poor data and rate by person and household (national vs coastal provinces)

Province/Area	Poor persons	Persons rate (%)	Poor households	Households rate (%)
Kampot	110,044	15.53	28,743	17.79
Preah Sihanouk	38,775	16.91	8,445	16.71
Koh Kong	34,997	38.53	7,990	25.36
Kep	5,636	13.05	1,408	14.23
Coastal (total)	189,452	21.01	46,586	18.52

Cambodia (National)	3,348,026	21.46	751,323	19.19

Source: MoP, IDPoor Public Data Query

Annex Table 2-6 Cambodia's HDI, 1990–2023 (UNDP HDR 2023/24 Statistical Annex)

Year	HDI Value	Life expectancy at birth	Expected years of schooling	Mean years of schooling	GNI per capita (2021 PPP$)	Inequality Adjusted HDI
1990	0.387	55.21	6.89	2.82	1209.60	…
1991	0.392	55.58	6.99	2.87	1241.33	…
1992	0.396	55.75	7.10	2.93	1263.47	…
1993	0.399	56.04	7.21	2.98	1250.66	…
1994	0.400	56.22	7.31	3.04	1217.33	…
1995	0.404	56.56	7.42	3.09	1228.19	…
1996	0.408	56.83	7.53	3.15	1261.15	…
1997	0.414	57.27	7.64	3.20	1299.83	…
1998	0.419	57.86	7.74	3.26	1324.98	…
1999	0.429	58.61	7.85	3.32	1449.30	…
2000	0.438	59.49	7.96	3.37	1557.66	…
2001	0.453	60.46	8.59	3.44	1650.32	…
2002	0.473	61.40	9.78	3.50	1712.62	…
2003	0.488	62.35	10.33	3.56	1836.39	…
2004	0.502	63.26	10.84	3.62	1986.09	…
2005	0.514	64.11	11.00	3.69	2196.73	…
2006	0.525	64.89	11.16	3.81	2395.49	…
2007	0.534	65.55	11.16	3.93	2611.42	…
2008	0.539	66.15	11.06	4.03	2721.60	…
2009	0.539	66.75	11.07	3.94	2674.14	…
2010	0.543	67.31	11.07	3.87	2820.32	0.387
2011	0.547	67.87	11.08	3.80	2953.15	0.397
2012	0.551	68.37	11.09	3.74	3096.68	0.404
2013	0.554	68.76	11.10	3.67	3253.89	0.408
2014	0.557	69.12	11.11	3.60	3437.21	0.403
2015	0.562	69.40	11.12	3.67	3629.06	0.407
2016	0.570	69.64	11.13	3.95	3839.20	0.414
2017	0.578	69.84	11.14	4.23	4057.35	0.421
2018	0.586	69.99	11.15	4.52	4284.37	0.427
2019	0.593	70.13	11.16	4.80	4508.79	0.433
2020	0.595	70.06	11.17	5.00	4415.43	0.435
2021	0.594	69.30	11.18	5.20	4425.37	0.434
2022	0.602	70.53	11.19	5.20	4612.26	0.440

2023	0.606	70.67	11.20	5.20	4931.02	0.444

Source: *UNDP, 2024. Human Development Report 2023/24 – Statistical Annex. Data Center*

Annex Table 2-7 Subnational Human Development Index (HDI)-Cambodia 1990-2023

Year	HDI Value		Life expectancy at birth		Expected years of schooling		Mean years of schooling	
	Sihanoul Kampot Kep	Koh Kong	Sihanoul Kampot Kep	Koh Kong	Sihanoul Kampot Kep	Koh Kong	Sihanoul Kampot Kep	Koh Kong
1990	0.378	0.368	55.17	58.76	7.329	5.427	2.913	2.51
1991	0.383	0.373	55.52	59.14	7.442	5.511	2.969	2.558
1992	0.387	0.377	55.75	59.38	7.556	5.595	3.026	2.607
1993	0.39	0.379	55.81	59.44	7.671	5.68	3.082	2.655
1994	0.392	0.381	55.76	59.4	7.785	5.765	3.138	2.704
1995	0.399	0.387	56.04	59.69	7.9	5.85	3.195	2.752
1996	0.402	0.391	56.07	59.73	8.014	5.934	3.253	2.803
1997	0.407	0.396	56.47	60.15	8.129	6.019	3.311	2.853
1998	0.412	0.4	56.75	60.45	8.243	6.104	3.37	2.904
1999	0.421	0.409	57.41	61.15	8.357	6.189	3.428	2.954
2000	0.431	0.418	58.34	62.14	8.472	6.273	3.487	3.004
2001	0.448	0.432	60.11	63.27	9.173	6.749	3.49	3.009
2002	0.471	0.45	61.8	64.31	10.46	7.65	3.494	3.015
2003	0.488	0.463	63.55	65.37	11.07	8.052	3.499	3.021
2004	0.504	0.475	65.03	66.15	11.65	8.431	3.503	3.027
2005	0.517	0.484	66.22	66.63	11.84	8.529	3.508	3.033
2006	0.526	0.499	66.54	66.84	11.95	9.077	3.637	3.148
2007	0.532	0.513	66.78	66.97	11.89	9.491	3.765	3.263
2008	0.535	0.522	67.08	67.17	11.71	9.795	3.878	3.365
2009	0.535	0.528	67.63	67.62	11.7	10.23	3.8	3.3
2010	0.537	0.536	67.47	67.36	11.7	10.65	3.745	3.256
2011	0.544	0.549	68.45	68.08	11.72	11.08	3.763	3.419
2012	0.55	0.561	69.23	68.6	11.74	11.53	3.775	3.568
2013	0.556	0.573	69.89	69.01	11.75	11.98	3.782	3.702
2014	0.562	0.585	70.59	69.46	11.77	12.46	3.784	3.823
2015	0.563	0.58	70.37	69.73	11.56	11.94	3.835	3.797
2016	0.568	0.578	70.38	70.2	11.34	11.4	4.098	3.977
2017	0.572	0.576	70.33	70.62	11.11	10.85	4.358	4.146
2018	0.575	0.572	70.03	70.79	10.84	10.25	4.615	4.305
2019	0.578	0.568	69.83	71.04	10.57	9.638	4.87	4.453
2020	0.574	0.557	69.24	70.88	10.29	9.009	5.039	4.518
2021	0.57	0.545	68.11	70.16	9.982	8.353	5.207	4.577
2022	0.573	0.548	68.41	70.47	9.982	8.353	5.207	4.577

Source: *Global Data Lab, 2025.*

C. Economic activities

Economic indicators describe the structure and dynamics of Cambodia's economy, with emphasis on sectors that are important for coastal livelihoods. Key variables include GDP per capita (current and constant prices), sectoral shares of GDP (agriculture, industry, services), and, where data permit, the contribution of fisheries, tourism, ports and related coastal activities. National series are taken from World Bank World Development Indicators and national accounts; coastal insights draw on sector studies, blue-economy assessments and project documents. The annex documents how current-price values are converted to constant terms, how growth rates are calculated, and how qualitative statements on coastal economic importance are derived from available evidence.

Annex Table 2-8 Economic activity indicators: data sources, metadata, & aeesement methods

Indicator	Definition & Unit	Spatial Coverage	Time Series Availability	Data Sources	Computation / Notes
GDP per capita	US$/person (current + constant)	National	**1995–2024** (annual)	World Bank WDI	Constant series used for long-term trends; current for comparison.
Sectoral GDP shares	% of GDP from agriculture, industry, services	National	**1995–2024**	WDI; National Accounts	Interpreted for coastal economy via sector profiles (tourism, fisheries).
Fisheries contribution	% GDP or value added	National (coastal relevance)	Varies by study	World Bank CCDR; FiA; PEMSEA & MoE	Not annual; compiled from specialized assessments.
Tourism activity	Arrivals, receipts	National; coastal inference	1995–2024	MoT; project reports	Coastal-specific tourism data limited; interpret qualitatively.
Port & SEZ activity	Cargo volumes, employment	Preah Sihanouk; Phnom Penh	2010–2024 (irregular)	MPWT; SEZ reports	Used to contextualize coastal economic structure.
Employment structure	% employment by sector	National; limited coastal	LFS years: **2012, 2015, 2019, 2021–2023**	NIS Labour Force Survey	Used qualitatively to describe

					livelihood dependency.
Informality & migration flows	Share of informal workers; migration volumes	National	Intermittent	ILO; World Bank	No consistent coastal time-series; used as narrative support.

Annex Table 2-9 Cambodia's economic key indicators (1995-2024)

Year	GDP per capita		Agriculture, forestry, and fishing, value added		Services value added	
	Current US$	2015 US$	Constant 2015 US$ - Billion	% of GDP	Constant 2015 US$ - Billion	% of GDP
1995	343.49	520.93	2.26	47.72	1.95	34.192
1996	324.66	511.67	2.32	44.46	2.13	35.981
1997	297.59	496.77	2.35	44.45	2.19	35.088
1998	258.78	499.02	2.46	44.48	2.30	34.804
1999	286.75	552.90	2.55	40.90	2.63	35.442
2000	296.43	598.56	2.61	35.53	2.87	36.715
2001	327.50	632.83	2.70	32.97	3.15	38.058
2002	350.15	662.19	2.63	29.61	3.41	38.999
2003	386.69	719.33	2.95	29.47	3.72	38.730
2004	444.20	775.85	2.94	26.63	4.16	39.444
2005	525.80	866.34	3.42	27.45	4.66	39.354
2006	612.25	947.07	3.62	26.29	5.17	39.113
2007	731.69	1,030.23	3.83	25.47	5.72	39.167
2008	866.28	1,090.57	4.06	28.03	6.25	39.486
2009	875.75	1,117.26	4.28	28.09	6.52	39.788
2010	952.27	1,155.85	4.47	27.87	6.85	39.721
2011	1,088.98	1,221.39	4.58	28.04	7.31	39.083
2012	1,192.80	1,295.25	4.78	26.80	7.93	39.400
2013	1,305.66	1,376.30	4.83	24.45	8.69	40.406
2014	1,431.56	1,464.53	4.86	22.19	9.54	41.689
2015	1,547.32	1,547.32	4.87	20.14	10.20	42.206
2016	1,675.20	1,645.47	4.93	18.91	10.90	41.764
2017	1,826.35	1,753.94	5.02	17.87	11.66	41.418
2018	2,036.67	1,884.28	5.07	16.50	12.49	40.220
2019	2,225.88	2,008.32	5.05	15.44	13.30	39.138
2020	2,081.74	1,908.63	5.08	17.04	12.42	39.144
2021	2,167.40	1,938.76	5.16	16.90	12.19	36.487
2022	2,325.03	2,011.27	5.19	16.54	12.63	36.385
2023	2,429.75	2,085.06	5.25	17.08	13.39	36.152

2024	2,627.88	2,183.56	5.30	16.58	13.97	35.595

Source: *World Bank, 2025. World Development Indicators (WDI)*

D. Climate-related threats

Climate-related threat indicators summarize the frequency and severity of hazard events and the underlying climate trends affecting coastal communities. They include counts of major floods, droughts and storms; associated deaths, people affected and economic losses; and long-term trends in temperature, rainfall variability and sea-level rise. Disaster statistics are compiled from EM-DAT and national disaster-management records, while climate trends and projections use the World Bank Climate Change Knowledge Portal and national hydro-meteorological datasets. Indicators are normalised where appropriate (e.g. losses per capita) and, when possible, disaggregated to coastal provinces. The annex explains event classifications, treatment of missing values, and the limitations of historical records when interpreting climate-risk patterns.

Annex Table 2-10 Climate-related threats: data sources, metadata, metadata, & aeesement methods

Indicator	Definition & Unit	Spatial Coverage	Time Series Availability	Data Sources	Methods / Notes
Rainfall variability	Annual & seasonal rainfall (mm)	National	1960–2023	WB CCKP; hydro-met records	Variability assessed using coefficient of variation and seasonal anomalies.
Sea-level rise projections	cm relative to baseline	Coastal provinces	Projections to **2050/2100**	WB CCKP (IPCC AR6 pathways)	Range-based (low–high scenarios); province-level interpretation.
Flood events	Number of events; people affected; damage	National & provincial	**2000–2024**	EM-DAT; NCDM	Event classification standardised; damages expressed in '000 US$.
Drought events	Number of events; affected population	National & provincial	2000–2024	EM-DAT; national records	Data patchy pre-2010; descriptive trend only.
Storms & coastal hazards	# of events; affected areas	National; coastal areas	2000–2024	EM-DAT; DRM reports	Used to identify exposure hotspots.
Climate vulnerability factors	Exposure + sensitivity + adaptive capacity	National; provincial	Cross-sectional	Derived from multiple indicators	Composite index (qualitative); no time-series.

Annex Table 2-11 Summary of Major Climate- and Weather-Related Disasters in Cambodia, 2000–2023 (EM-DAT and CFE-DMHA Compilation)

Disaster Subtype	Locations	Year	Total Deaths	No. Injured	No. Affected	Total Damage ('000 US$)	Total Damage, Adjusted ('000 US$)
Riverine flood	Stung Treng, Kratie, Koh Kong, Kampong Cham, Pursat, Kampong Thom, Takeo, Siem Reap, Otdar Meanchey, Kampot, Svay Rieng, Kandal, Phnom Penh, Prey Veng, Kampong Chhnang, Ratanak Kiri, Preah Vihear, Battambang, Banteay Meanchey, Kampong Speu provinces	2000	347	53	3448000	160000	291465
Riverine flood	Stung Treng, Kratie, Kampong Cham provinces	2001	56		1669182	15000	26574
Drought	Kampong Cham, Kampong Chhnang, Kampong Speu, Kampong Thom, Kampot, Kandal, Kep, Koh Kong,	2001			300000		

	Kratie, Phnom Penh, Preah Sihanouk, Prey Veng, Pursat, Svay Rieng, Takeo provinces						
Riverine flood	Kandal, Stung Treng, Prey Veng, Takeo, Kampong Chhnang, Banteay Meanchey, Svay Rieng, Kampong Speu, Kratie, Pursat, Kampot provinces	2002	29		1470000	100	174
Drought	Takeo, Kampot, Kampong Speu, Kampong Chhnang, Kandal, Prey Veng, Phnom Penh,Otdar Meanchey, Banteay Meanchey, Pursat, Battambang provinces	2002			650000	38000	66269
Riverine flood	Kampong Cham, Kampong Chhnang, Kampong Speu, Kampong Thom, Kampot, Kandal, Kratie, Phnom Penh, Preah Vihear, Prey	2004					

	Veng, Stung Treng, Takeo provinces						
Riverine flood	Kratie, Kampong Cham, Kandal, Prey Veng, Siem Reap provinces	2005	16				
Drought	Kampong Speu province	2005			600000		
Riverine flood	Koh Kong province	2006			5000		
Riverine flood	Kampong Seila district (Koh Kong province), Phnom Penh, Kampong Speu, Kampot, Ratanak Kiri, Mondul Kiri provinces	2006	5		33000		
Riverine flood	Kampong Thom, Ratanak Kiri, Preah Vihear provinces	2007	2		19000	1000	1513
Tropical cyclone	Kampong Thom, Kratie, Mondul Kiri, Preah Vihear, Ratanak Kiri, Stung Treng provinces	2009	17	91	178000		
Tropical cyclone	Kaoh Nheaek district (Mondul Kiri province)	2009	2				
Riverine flood	Banteay Meanchey, Battambang, Otdar Meanchey,	2010	8			70000	100700

	Pailin, Preah Vihear, Pursat provinces						
Riverine flood	Kandal, Kampong Thom, Prey Veng, Kampong Cham, Kratie, Battambang, Kampong Chhnang, Preah Vihear, Pursat provinces	2011	247	23	1640000	521000	726561
Flash flood	Banteay Meanchey province	2012	14		71500		
Riverine flood	Battambang, Banteay Meanchey, Kampong Cham, Prey Veng, Kandal, Siem Reap, Kratie, Kampong Thom, Otdar Meanchey, Stung Treng, Pursat, Kampong Chhnang, Ratanak Kiri, Preah Vihear, Svay Rieng, Phnom Penh, Takeo, Pailin, Kampot provinces	2013	200		1500000	500000	673276
Flash flood	Kampong Cham, Kampong Chhnang, Kampong Speu,	2014	45		472500	2000	2650

	Kampong Thom, Kampot, Kandal, Kratie, Phnom Penh, Preah Vihear, Prey Veng, Stung Treng, Takeo provinces						
Flood (General)	Teuk Chhou District (Kampot) (Mak Prang, Kampong Kreng, Stoeung Keo, Trapang Thum and Prey Khmum communes)	2015			22000		
Tropical cyclone	Battambang province	2015			6300		
Drought	Banteay Meanchey, Battambang, Pursat, Kampong Speu provinces	2016			2500000		
Flood (General)	Siem Pang District, Steung Treng Town, Siem Bok,Sesan, Thalaborivat; Kampong Speu, Battambang, Koh Kong, Phreah Sihanouk , Kampot provinces	2018			5817		
Flood (General)	Stung Treng, Kratie, Kampong Cham and	2019	12		435000		

	Tbong Khmum						
Tropical cyclone	Pursat, Battambang, Pailin, Kampong Speu, Kampong Chhnang, Banteay Meanchey, Kampong Thom, Phnom Penh, Kandal, Sway Rieng, Stung Treng, Takao, Siem Reap, Preah Videar, Oddar Meanchey Provinces.	2020	44		759360	100000	121204
Tropical cyclone	Battambang, Preah Sihanouk and Koh Kong Provinces.	2020					
Flood (General)	Poipet and Malai districts (Banteay Meanchey Province)	2021			500		
Flood (General)	Kampong Speu Province	2021			225		
Flood (General)	Daun Kok and Anlong Svay villages, Sangkat Boeung Thom, Khan Kampoul, Phnom Penh	2021			12500		
Severe weather	Banteay Ampil district (Oddar Meanchey province);	2021	1	1	500		

	Battambang province; Krakor District (Pursat province)						
Flood (General)	Meanchey, Oddar Meanchey Province	2022	15		167770		
Storm surge	National	2022	16				
Lightning/ Thunderstorms	National	2023			14100		

Source: *CRED, UCLouvain, 2025. EM-DAT: The International Disaster Database [dataset]*

Annex 3

Annex 3-1 Dataset and analysis framework, and complimentary note

A. Core Water-Quality Indicators

This annex consolidates the core water-quality indicators used to diagnose organic pollution, nutrient enrichment and microbial contamination in Cambodia's rivers, estuaries and coastal waters. It draws primarily on MoE's river and coastal monitoring network, the Mekong River Commission's Water Quality Monitoring Network (WQMN), and JICA drainage and sewerage studies in Phnom Penh. These datasets provide multi-year information on BOD, TSS, total nitrogen (TN), total phosphorus (TP), and fecal coliforms/E. coli, which together underpin the RQ and WQI analyses in the chapter.

The indicators are used to detect hotspots where nutrient and microbial concentrations exceed Cambodian and ASEAN standards, and to trace land-based pollution pathways from Phnom Penh and major tributaries to coastal estuaries such as Kampot, Kep and Prek Toeuk Sap. Time-series trends (2010–2023) help identify whether conditions are improving, stable or deteriorating, and provide an empirical basis for classifying risk levels and prioritising interventions.

Annex Table 3-1 Core water-quality indicators: data sources, metadata, and assessment method

Category	Details
Data Sources	• MoE river & coastal monitoring network (BOD, TSS, TN, TP, FC; c.2015–2023) • MRC WQMN (Mekong, Tonle Sap, Bassac stations; nutrients & coliforms; 2012–2022) • JICA drainage & sewerage studies for Phnom Penh canals (Trabek, Tumpun; 2010–2013) • ADB/MoE special surveys in Kep and selected estuaries.
Metadata	• Parameters: BOD, TSS, TN, TP, fecal coliforms/E. coli. • Units: mg/L (BOD, TSS, TN, TP); CFU/100 mL or MPN/100 mL (microbial). • Coverage: main Mekong–Tonle Sap–Bassac stations plus coastal/estuarine sites in Kampot, Kep, Koh Kong, Preah Sihanouk.

	• Frequency: typically monthly–quarterly; higher for some JICA canal datasets. • Reference standards: Cambodian ambient water standards and ASEAN Marine Water Quality Guidelines.
Assessment Method	• Compute RQ = observed / standard for each parameter and station to classify risk (RQ<1 compliant; 1–2 moderate; >2 high; >3–5 severe). • Derive simple Water Quality Index (WQI) classes (good–very poor) from DO, BOD, TN/TP, coliforms and TSS where data allow. • Map hotspots where multiple parameters exceed thresholds over several years (e.g. Phnom Penh confluence, Kampot estuary, Prek Toeuk Sap). • Compare trends over time to judge whether nutrient and microbial loads are increasing or stabilising.

The combined BOD, TSS, TN, TP and coliform datasets demonstrate that chronic nutrient and microbial exceedances now affect multiple estuaries, particularly downstream of Phnom Penh and in semi-enclosed coastal bays. RQ and WQI scores highlight "poor–very poor" conditions in canals and estuaries feeding the Mekong–Bassac system and key coastal hotspots, supporting the chapter's conclusion that untreated wastewater, agriculture and aquaculture are the dominant drivers of eutrophication and public-health risk.

Annex Table 3-2 Water quality indicator summary (BOD, TSS, TN, TP, FC)

Indicator	Units	Data Sources	Sampling Frequency	Method / Standard	Key Use in Analysis
BOD	mg/L	MoE; MRC; JICA	Monthly–Quarterly	APHA 5210 B (5-day BOD)	Organic pollution; wastewater load; RQ & WQI sub-index
TSS	mg/L	MoE; JICA; MRC	Monthly–Seasonal	Gravimetric method	Sediment stress, estuary siltation, coastal turbidity
Total N (TN)	mg/L	MoE; MRC; WEPA	Monthly–Quarterly	Spectrophotometric (APHA 4500-N)	Nutrient enrichment; eutrophication; RQ mapping
Total P (TP)	mg/L	MRC; MoE	Monthly–Quarterly	Molybdenum Blue (APHA 4500-P)	Eutrophication; bloom risks; hotspot detection
Fecal Coliform / E. coli	CFU/100 mL	MoE; ADB; MRC	Monthly	MPN (Multiple-tube)	Public health risk; WQI microbial index; tourism risk

B. Industrial and Port Pollutants*: Hydrocarbons (Oil & Grease, TPH) and* Heavy Metals (Pb, Zn, Cu)

This annex summarises data on hydrocarbons (oil & grease, total petroleum hydrocarbons – TPH) and heavy metals (Pb, Zn, Cu) in port areas and coastal sediments. The main focus is Sihanoukville Port and surrounding SEZs, as well as industrialised estuaries such as Prek Toeuk Sap and Stung Hav. Monitoring by MoE, complemented by FiA/UNDP habitat studies, documents both water-column exceedances of national effluent standards and long-term metal accumulation in mangrove and estuarine sediments.

These indicators are used to identify toxic "hotspots" where industrial and port activities pose risks to marine life, food safety and transboundary pollution through Gulf of Thailand currents.

Annex Table 3-3 Industrial and port pollutants: data sources, metadata, and assessment method

Category	Details
Data Sources	• MoE industrial effluent and port-area monitoring (oil & grease, TPH, Pb, Zn; 2022–2023). • MoE sediment studies in Peam Krasop, Stung Hav, Koh Kong estuaries (metals, hydrocarbons). • FiA/UNDP habitat assessments (mangrove and seagrass sediment cores). • SEZ and port environmental reports (PAS, SEZ WWTP performance).
Metadata	• Parameters: Oil & Grease, TPH, Pb, Zn, Cu. • Units: mg/L (water), mg/kg (sediment). • Spatial focus: Sihanoukville Port, Prek Toeuk Sap, Stung Hav Bay, selected mangrove sites in Koh Kong and Peam Krasop. • Standards: Cambodian effluent limits (e.g. O&G ≤5 mg/L; TPH ≤0.5 mg/L; Pb ≤0.1 mg/L; Zn ≤1.0 mg/L) and international sediment-quality guidelines.
Assessment Method	• Calculate RQ for each parameter relative to national limits to assess facility compliance (e.g. RQ>1 for O&G, TPH, Pb, Zn). • Compare sediment concentrations with pre-2000 baselines and guideline values to infer long-term accumulation and ecological risk. • Identify spatial clusters of non-compliance and sediment hotspots around ports and SEZ discharges. • Qualitatively link hotspots to industrial activities, ship repair zones and port drainage patterns.

The industrial and port-pollution datasets show that around 60% of inspected facilities are non-compliant with effluent standards, with RQ values >1 for oil & grease, TPH, Pb and Zn in port-adjacent waters. Sediment records confirm chronic accumulation of metals in mangrove and estuarine environments, signalling long-term toxicity risks for benthic organisms and seafood consumers, and underlining the need for stronger port-based controls and hazardous-waste management.

Annex Table 3-4 Industrial/port pollutants (hydrocarbons & heavy metals) indicator summary

Indicator	Units	Data Source	National Standard	Methods	Notes
Oil & Grease	mg/L	MoE (2022–2023)	≤5 mg/L	Infrared spectro	Exceedances at PAS, Stung Hav

TPH	mg/L	MoE	≤0.5 mg/L	GC or IR	Chronic low-level contamination around port
Lead (Pb)	mg/L (water) / mg/kg (sediment)	MoE; FiA/UNDP	≤0.1 mg/L	AAS	Sediments show 10–25 mg/kg accumulation
Zinc (Zn)	mg/L / mg/kg	MoE	≤1.0 mg/L	AAS	Elevated in estuaries (35–90 mg/kg)
Copper (Cu)	mg/kg (sediment)	MoE; FiA	—	AAS	Consistent increase in sediments (12–28 mg/kg)

C. Solid Waste and Marine Litter

This annex collates data on municipal solid waste generation, collection efficiency, marine litter and microplastic contamination in coastal areas. It integrates MoE national waste baselines, municipal waste data from coastal provinces, UNDP and ADB beach-litter surveys, and FiA/UNDP sediment microplastic studies.

These datasets are used to estimate plastic leakage from land to sea, document spatial patterns of beach litter, and quantify microplastic abundance in nearshore sediments, providing a basis for assessing Cambodia's contribution to regional marine-litter loads in the Gulf of Thailand.

Annex Table 3-5 Solid Waste, Marine Litter and Microplastics: Data Sources, Metadata, and Assessment Method

Category	**Details**
Data Sources	• MoE National Waste Baseline and provincial waste diagnostics (2018–2023). UNDP and ADB studies on municipal waste and marine litter in Phnom Penh and coastal cities. • Beach-litter surveys following UNEP/COBSEA protocols (ADB, UNDP). • FiA & UNDP sediment microplastic surveys (Otres, Ream, Koh Rong/Sanloem, Kep).
Metadata	• • Indicators: waste generation (t/day, t/year); collection coverage (%); plastic fraction of MSW; beach-litter density (items/m^2); sediment microplastic abundance (particles/kg). • Spatial coverage: four coastal provinces plus Phnom Penh; key beaches and ports. • Timeframe: baseline around 2018–2023; some trend data for Phnom Penh.
Assessment Method	• Combine generation and collection data to estimate uncollected waste and coastal plastic leakage (>14,000 t/year). • Use standardised transects to compare litter densities across sites and identify tourism-dominated hotspots. • Analyse microplastic counts in sediments (120–350 particles/kg) to classify contamination levels and associate with nearby sources (ports, river mouths, tourism areas). • Interpret results in relation to regional circulation models to infer transboundary transport of plastics and microplastics.

The solid-waste and marine-litter datasets show that low collection rates and unengineered dumpsites generate substantial plastic leakage to rivers and coastal waters. Beach and sediment surveys confirm that plastics dominate shoreline debris and that microplastic contamination is already widespread near ports and tourist beaches. These findings support the chapter's conclusion that marine litter and microplastics represent a rapidly escalating, transboundary pollution issue requiring coordinated land-based waste reforms and Gulf-wide cooperation.

D. Hazardous and Medical Waste

This annex synthesises information on industrial hazardous waste and medical waste, including COVID-19-related surges, and compares estimated waste generation with national treatment capacity. It draws on UNDP and Business Scouts for Development (GIZ) sector studies, Korean knowledge-sharing programmes, UNCRD country summaries, and facility data for the Chip Mong Ecocycle co-processing plant and medical-waste incinerators.

The indicators are used to assess whether hazardous and medical wastes are likely to be managed within licensed facilities or are at risk of informal dumping, co-disposal with municipal waste or uncontrolled burning.

Annex Table 3-6 Hazardous and medical waste: data sources, metadata, and assessment method

Category	**Details**
Data Sources	• UNDP and GIZ/Business Scouts sector briefs on waste management and medical waste (2020–2023). • Korean KSP/KDI policy studies on industrial waste. • UNCRD reports on hazardous-waste co-processing in cement kilns. • MoH and facility reports on medical-waste incineration capacity.
Metadata	• Indicators: estimated industrial hazardous/"collected industrial" waste (t/year); routine and COVID-peak medical waste (t/year); licensed co-processing capacity (~150,000 t/year); number and size of medical-waste incinerators (~34 units). • Spatial coverage: national, with concentration in Phnom Penh and industrial hubs; co-processing facility in Kampot.
Assessment Method	• Compile reported waste generation by sector and compare with licensed treatment capacity to identify gaps and potential uncontrolled disposal. • Map provinces and sectors without reasonable access to licensed hazardous-waste facilities. • Classify overall risk qualitatively (low/medium/high) based on generation-to-capacity ratios, transport distances, and known informal practices (open burning, on-site burial, co-disposal at dumpsites).

Available data suggest that industrial and medical hazardous wastes are increasing faster than licensed treatment capacity. While the Kampot co-processing facility provides substantial nominal capacity, geographic concentration and limited coverage for smaller generators mean that many hazardous streams are likely mismanaged. This reinforces the chapter's conclusion that hazardous-waste mismanagement is a medium but growing risk, especially where residues can leach into waterways or be co-disposed with municipal waste in unlined dumps.

Annex Table 3-7 Hazardous and medical waste indicator summary

Category	Indicator	Units	Sources	Methods	Notes
Industrial hazardous waste	Estimated industrial hazardous/collected industrial waste	t/year	UNDP (2021); Business Scouts for Development (2023); KSP/KDI studies; facility reports	Compile reported annual waste volumes by facility/sector; compare with national hazardous-waste definitions	Around 120,000 t/year "collected industrial waste" reported; only a portion formally recorded as hazardous; significant uncertainty on informal/unregistered generators.
Medical waste (pre-COVID)	Routine medical waste generation	t/year	UNDP (2021); MoH/health-facility reports	Sum reported monthly/annual waste from hospitals and health centres; extrapolate to national level	Pre-COVID estimates ≈40 t/month (~480 t/year) in Phnom Penh; lower volumes in provinces with weak reporting.
Medical waste (COVID surge)	Pandemic-related surge in medical waste	t/year	UNDP (2021); emergency-response documentation	Compare peak daily generation with pre-COVID baselines; estimate annualised surge	COVID period peaks up to ~20 t/day (~7,300 t/year) in Phnom Penh; stress-tested existing incinerators and storage capacity.
Treatment capacity – co-processing	Hazardous-waste co-processing capacity (cement kiln)	t/year	UNCRD (2023); company reports (Chip Mong Ecocycle)	Review licensed capacity; cross-check with reported annual inputs	Nominal capacity ≈150,000 t/year; actual throughput lower; capacity mainly in Kampot, far from northern/remote generators.
Treatment capacity – medical waste	Number and capacity of medical-waste incinerators	units; t/year	GIZ (2020); UNCRD (2023); MoH	Inventory of installed incinerators; estimate throughput based on design capacity	~34 incinerators nationwide (incl. 5 new JICA units); many small, intermittent operation; limited emission

				and operating days	controls and ash management.
Sectoral risk mapping	Mismatch between waste generation and licensed treatment	ratio; qualitative rating	All above	Compare estimated generation vs. licensed capacity; map provinces with no access to licensed facilities	High-risk sectors: small/medium industries, clinics, labs; risks include illegal dumping, on-site burial, co-disposal with municipal waste and open burning.

E. Hydrology and atmospheric (Discharge, Catchment Area, Flow Reversal)

This annex summarises the hydrological and atmospheric datasets used to understand how pollutants are transported from inland hotspots to the coast and across borders. It relies on MRC hydrological records (discharge, flow reversal, catchment areas), MoE/WEPA reports, and regional acid-deposition and air-pollution assessments (EANET/PRSAD4, MICS-Asia).

Hydrological indicators are used to estimate pollutant loads (BOD, TSS, TN, TP) at key stations and to identify major river-to-sea pathways, while atmospheric datasets frame the relative contribution of airborne sulphur and nitrogen deposition to coastal nutrient budgets.

Annex Table 3-8 Hydrology and transport: data sources, metadata, and assessment method

Category	Details
Data Sources	• MRC hydrological datasets for Mekong, Tonle Sap and Bassac (discharge, TSS). • MoE/WEPA water-environment assessments. • Peer-reviewed studies on Tonle Sap flow reversal and catchment characteristics. • EANET PRSAD4 and related regional modelling (MICS-Asia) for SO_2 and NO_x deposition.
Metadata	• Indicators: mean and seasonal discharge (m^3/s); reverse-flow volume for Tonle Sap (~30 km^3/year); TSS and nutrient concentrations at key stations; wet deposition of nitrogen and sulphur (kg/ha/year). • Spatial coverage: Mekong mainstream, Tonle Sap River, Bassac River (Koh Khel/border), and main coastal rivers (Kampot, Tatai, Prek Toeuk Sap). • Temporal coverage: mainly 2010–2022, with longer historical context where available.
Assessment Method	• Calculate annual pollutant loads (t/year) using $L = C \times Q \times$ conversion factor, where concentration and discharge data co-exist. • Rank river reaches and tributaries by relative contribution to downstream nutrient and sediment loads.

	• Use qualitative pathway mapping to trace transport from Phnom Penh canals and MTB system to the Vietnamese delta and Gulf of Thailand. • Interpret atmospheric deposition data in relation to terrestrial nutrient sources to judge its relative significance.

Hydrological analysis confirms that the Mekong–Tonle Sap–Bassac system is the dominant pathway for nutrient and microbial export from Cambodia to the Vietnamese delta, while coastal rivers such as Kampot and Tatai deliver concentrated loads from local agricultural and urban sources directly to sensitive estuaries. Combined with regional circulation and deposition data, these findings underpin the chapter's identification of transboundary pollution linkages in both riverine and marine compartments.

Annex Table 3-9 Hydrology (discharge, catchment area, flow reversal) indicator summary

Category	Indicator	Units	Sources	Methods	Notes
Mekong mainstream	Mean annual discharge at Phnom Penh / Kratie	m³/s	MRC hydrological datasets; MRC annual reports	Analyze long-term gauging-station records; compute mean and seasonal range	Mekong at Kratie ≈14,500 m³/s (order of magnitude); large discharge provides strong dilution but also rapid downstream transport of pollutants.
Bassac River (Tonlé Bassac)	Discharge at Koh Khel / border reach	m³/s	MRC WQMN & hydrology; national river reports	Use rating curves and stage–discharge relationships; interpolate for missing years	Key conduit of Phnom Penh pollutants to Viet Nam; discharge ~10,000 m³/s in wet season; used for pollutant-load estimates where concentration data exist.
Tonlé Sap River & Lake	Catchment area; reverse flow volume	km²; km³/year	Peer-reviewed Tonlé Sap studies; MRC basin reports	Derive catchment from GIS; use published reverse-flow estimates (e.g., 30 km³/year)	Catchment ≈87,940 km²; unique flow reversal sends Mekong water into the lake in wet season and back out in dry season, redistributing nutrient and

					sediment loads.
National river network	Major river lengths & catchments (Mekong, Tonlé Sap, Bassac, coastal rivers)	km; km²	MRC & MoE river atlases; national topographic maps	GIS delineation of catchments; digitised river networks	Used to normalise pollutant loads (e.g., t/year per km²) and to identify sub-basins contributing to coastal hotspots (Tatai, Kampot, Prek Toeuk Sap).
Pollutant load estimation	Loads for BOD, TSS, TN, TP at key stations	t/year	Combination of hydrological data (MRC) and water-quality datasets (MoE, JICA, MRC)	Apply L = C × Q × 31.536 (for mg/L × m³/s → t/year); seasonal disaggregation where wet/dry data available	Load estimates are used to rank river reaches as low/medium/high contributors to downstream coastal pollution; uncertainties flagged where discharge or concentration data are sparse.
River-to-sea pathway mapping	Connectivity from inland hotspots to coastal/ transboundary zones	qualitative (maps; pathway descriptions)	All above; plus regional circulation studies	Overlay river network, discharge, and monitoring hotspots; trace main pollutant pathways to Gulf of Thailand and Vietnamese delta	Highlights Phnom Penh–Bassac–Viet Nam pathway and coastal rivers (Kampot, Tatai, Prek Toeuk Sap) as primary transport routes for land-based pollution to marine ecosystems.

Annex Table 3-10 Coastal & riverine pollution risk assessment

Risk category	Main pollutan	Likelihood	Key impacts	Main hotspots	Transboundary

	ts / drivers				significance
Nutrient enrichment & eutrophication	Fertilizer and pesticide runoff, aquaculture effluent, untreated municipal wastewater (NO_3^-, PO_4^{3-}, TSS)	**Very high**	Hypoxia (DO <4 mg/L), algal blooms, coral-cover decline, seagrass stress, reduced fisheries productivity	Kampot Bay, Kep, Sihanoukville, Trapeang Ropov, Peam Krasop, Kampot estuary	**High** – nutrients and organic matter transported within Gulf of Thailand and affect shared fisheries and water quality
Microbial contamination & public-health risk	Fecal coliforms, pathogens from low sewerage coverage and direct discharge	**Very high**	Waterborne disease, unsafe bathing water, fish-landing contamination, shellfish and food-safety risks, tourism losses	Phnom Penh Port/MTB system, Sihanoukville canals, Kep coastal waters, Prek Toeuk Sap, Tumpun Canal, Kampot River mouth	**Moderate–high** – microbial loads exported via Mekong–Bassac and coastal currents
Solid waste leakage & microplastics	Poorly managed municipal solid waste, plastics from tourism and urban areas	**High**	Ingestion/entanglement of fauna, seagrass and mangrove damage, beach and seabed litter, long-term microplastic buildup, visual pollution	Coastal cities and landfills in Koh Kong, Sihanoukville, Kampot, Kep; beaches and port areas	**Very high** – plastics transported around Gulf of Thailand, contributing to regional hotspots
Industrial & port-related contaminants	Non-compliant effluents (oil &	**Moderate –high** (spatially concentrated)	Chronic toxicity, bioaccumulation in fish, estuarine habitat degradation,	Sihanoukville Autonomous Port, Stung	**Moderate** – contaminated sediments and plumes transported

	grease, TPH, Pb, Zn, Cu) from SEZs, industry and ports		constraints for aquaculture	Hav cluster, Prek Toeuk Sap, Tumpun–Trabek canal system, Peam Krasop/Koh Kong	along nearshore shelf (esp. toward Thai border)
Oil spills & hydrocarbon pollution	Episodic spills, bilge water, ship repair and port operations	**Low–moderate** (but high consequence)	Acute smothering of coral and seagrass, fish kills, beach closures, tourism disruption, residual hydrocarbons in sediments	Port-adjacent waters, shipping lanes near Sihanoukville, Prek Treng coastline	**High** – strong currents can move slicks across borders within days
Hazardous waste mismanagement	Poorly tracked industrial, medical and hazardous wastes; limited treatment capacity	**Moderate**	Soil and groundwater contamination, toxic residues entering rivers/estuaries, long-term human-health risks	Industrial corridors, urban disposal sites, facilities lacking secure treatment	**Moderate** – mainly via Mekong–Bassac and coastal runoff pathways

Annex 4

Annex 4-1 Data sources

Mangroves

- **MoE Mangrove Assessment (2014, 2025):** national wall-to-wall mapping (Sentinel-2, 10 m) with consistent methods—chosen as the primary pair for recent trend detection and provincial disaggregation.
- **NSOC/PEMSEA compilations (1997, 2011):** used to contextualize the earlier contraction phase and to compare long-run magnitudes.
- **Global Mangrove Watch (v3.0):** global consistency check on 1996–2020 trajectories and spatial plausibility.

Coral reefs

- **CCRMN / FiA national monitoring (since 2019):** standardized line-intercept/photo-quadrats and belt transects for fish/invertebrates—used for mean live cover, life-form composition, and qualitative trend signals.
- **Legacy site surveys (Koh Rong/Kep/Kampot/Koh Sdach):** provide pre-2019 context and species-level richness.

Seagrass

- **MoE Seagrass Assessment (2014, 2025):** provincewide tallies with CFi-resolved meadows (Kep–Kampot) to support management-relevant accounting.
- **FFI–FiA 2021–2023 mapping (Koh Kong–Preah Sihanouk):** eleven-site campaign (e.g., Chrouy Pros, Steung Hav, Prey Nob) for area/patch morphology and ground validation.
- **MCC/FAO and partner baselines:** used where community patrol and anti-trawl pilots supply fine-scale edges and scars.

Wetlands/biodiversity & governance

- **Ramsar (Koh Kapik & Associated Islets) and Peam Krasop WS documents:** ecological function and household dependence.
- **Protected-area legal updates (ODC) & management plans:** boundary changes, governance status.
- **Bycatch/megafauna records:** peer-reviewed/technical notes (Irrawaddy dolphins, dugongs, turtles) to anchor risk pathways.

Water quality/pollution (context)

- **ASEAN Marine Water Quality Guidelines** and MoE routine checks (nutrients, BOD, coliforms) to interpret pressures on reefs/seagrass near growth nodes.

These sources were chosen for (i) national coverage with recent vintages, (ii) method transparency enabling cross-walks, and (iii) direct linkage to management units (MFMAs/CFis/CPAs/MNPs).

Annex 4-2 Indicator construction & computations

Change in mangrove extent (2014→2025)

- Harmonized class keys across the two MoE epochs; excluded known reclass artifacts (e.g., aquaculture pond edges, nipa-dominant fringes misread as non-mangrove).
- Reported both absolute (ha) and relative (%) change; flagged hotspot polygons where losses cluster (>500 ha within a 5-km radius).

Coral condition & structure

- **Live coral cover (%):** site means (±SD) from line-intercept/photo-quadrats; aggregated to island groups and provinces (inverse-variance weighting where available).

- **Life-form composition:** massive/encrusting vs branching/foliose shares to infer sediment/light stress.
- **Fish/invertebrate indicators:** density/biomass summarized by functional groups when transect lengths and ID levels were consistent; otherwise used qualitative categories (low/moderate/high relative to Gulf references).

Seagrass extent & sensitivity

- **Area (ha):** meadow polygons merged per CFi; overlaps resolved by priority to the most recent, ground-validated layer.
- **Edge stability & trawl scars:** where GPS patrol tracks and drone imagery existed, computed edge retreat/advance ($m \cdot yr^{-1}$) and scar density ($km \cdot km^{-2}$).
- **Light limitation proxy:** used turbidity notes and depth-of-occurrence shifts (when repeated depth belts were available) as qualitative Kd proxies.

Blue-carbon screening (order-of-magnitude)

- For policy framing only (not crediting): multiplied areas by Tier-1/2 stock factors from peer-reviewed syntheses for **mangrove peat** and **seagrass soils**; reported as ranges (±25–50%) and **not** used for valuation without site-level MRV.

Socio-ecological coupling

- Linked habitat units to adjacent CFis/settlements (2-km coastal buffer) to flag livelihood exposure where **>50%** of local income is wetland/fishery-derived (per Ramsar/field studies).
- For hotspot narratives, combined hydrologic connectivity (freshwater inlets, tidal prisms), nursery adjacency (mangrove⇄seagrass corridors), and enforcement footprint (patrol hours, anti-trawl deployments).

Trend language

- "Decline/Recovery" used only when (a) at least two independent observations with consistent method exist, or (b) one observation with strong ancillary evidence (e.g., trawl-scar proliferation, dredging chronology) and expert validation.

Annex 4-3 Spatial & temporal frame

Spatial definitions. Provincial boundaries follow official census geographies. Ecosystem units combine (i) national/provincial extents (mangroves, coral, seagrass, wetlands), (ii) legally designated areas (MNPs, MFMAs, Ramsar/WS/NP/PL), and (iii) community zones (CFis/CPAs) for co-management analyses. Where zoning overlaps (e.g., Koh Rong MNP over earlier MFMA), rules are harmonized by the most recent legal designation for maps/tables.

Time horizon

- **Mangroves:** long-run references (1997–2011) from NSOC compilations; recent change from **2014–2025** using MoE's ongoing Mangrove Assessment (Sentinel-2, 10 m).

- **Coral reefs:** condition/cover from 2010–2025 (legacy baselines; standardized national series since ~2019 with CCRMN).
- **Seagrass:** extent/condition anchored on **2014–2025** (provincewide compilations plus 2021–2023 mapping in Koh Kong/Preah Sihanouk; 2014 & 2025 for Kep–Kampot).
- **Wetlands/biodiversity:** site dossiers use source-year snapshots (Ramsar sheets, management plans, recent field reports).

Conflict/definition discontinuities. Where historical land-cover/extent products used different class keys (e.g., "mangrove woody wetland" vs "mangrove forest"), we built a cross-walk and report uncertainties with ranges rather than single-point change rates.

Annex 4-4 Quality assurance, triangulation & treatment of uncertainty

Cross-source checks. Mangrove totals were compared against GMW v3.0 tiles and legacy NSOC figures to validate provincial magnitudes and loss geography; discrepancies >5% triggered manual inspection (cloud/shadow, aquaculture glare, tidal phase). For seagrass, MoE polygons were cross-checked with FFI–FiA site campaigns and CFi sketch maps; conflicts favored the most recent ground-validated layer.

Method consistency. Coral cover aggregates only pooled transects with matching protocols; when methods differed, we presented site-level values and refrained from computing provincial means.

Administrative and zoning changes. Where protected-area boundaries changed (e.g., Peam Krasop WS, Botum Sakor NP), historical extents were re-tabulated to the **then-current** boundary for time-slice comparisons; we avoid per-hectare inferences across moving denominators.

Small-area volatility. Kep's small base and patchy nearshore reefs/meadows produce larger percentage swings; interpretations emphasize direction and management implications rather than fine-grained year-to-year rates.

Attribution limits. We avoid over-attributing change to single drivers when co-varying pressures (trawling, turbidity, shoreline works, heat stress) are plausible; language remains conditional ("consistent with…", "suggests…"), pending targeted studies.

Uncertainty reporting.

- Mapping: report class-level error where available (user's/producer's accuracy); otherwise qualify results as **indicative** and present rounded totals.
- Blue-carbon: provide wide ranges and flag the need for site MRV (plots/cores, hydrology) before any crediting or firm valuation.
- Biodiversity/bycatch: rely on documented events and conservative inference for risk pathways.

Reproducibility. Spatial layers and tabulations are archived with metadata on source, date, method, CRS, and any edits (smoothing, gap-filling). Summary scripts (where used) are versioned to regenerate province and hotspot tables/figures.

Annex 4-5 Extended explanatory note on mangrove and wetland status and site pressures

(Supporting Sections 4.2.1.1 and 4.2.1.2 of the main chapter)

A) Mangrove extent datasets and historical change

A1. Why national mangrove estimates differ

National mangrove extent varies widely (≈45,000–63,000 ha) because estimates depend on (i) the classification rules used to separate mangroves from other coastal woody vegetation, (ii) sensor resolution and cloud/tide conditions, and (iii) whether narrow fringing stands and mixed mangrove–scrub mosaics are included. Despite these differences, all sources agree that mangroves are concentrated in **Koh Kong**, with smaller estuarine belts in **Kampot–Preah Sihanouk** and minor patches in **Kep**. Dominant genera commonly reported include *Rhizophora*, *Avicennia* and *Sonneratia*.

A2. Historic decline (NSOC baseline) and likely drivers

Historic statistics compiled in NSOC 2018 indicate that Cambodia's coastal mangroves declined from **63,041 ha (1997)** to **50,860 ha (2011)**—a net loss of **12,181 ha** over 14 years (**≈−870 ha/year**; **−19.3%** from the 1997 baseline). Spatially, the steepest contractions were reported in the **Botum Sakor/Koh Kong complex** and **Kampong Trach (Kampot)**, which align with known fronts of aquaculture/estate expansion, settlement growth and charcoal production during the late-1990s to mid-2000s period (PEMSEA & MoE, 2019). This historic interval is important for interpretation: it suggests that a large share of national mangrove loss occurred during earlier development phases, and that present-day loss rates should be interpreted against this longer-term trajectory.

A3. Recent mapping (MoE Mangrove Assessment 2014–2025) and provincial pattern

According to MoE's ongoing Mangrove Assessment (Sentinel-2, 10 m), national mangrove extent declined from **58,866 ha (2014)** to **55,355 ha (2025)**—a net loss of **3,510 ha** across 11 years (**≈−319 ha/year**; **−6.0%** relative to the 2014 baseline). Losses are uneven: **Koh Kong accounts for ~2,259 ha (≈64%)** of total loss and **Preah Sihanouk ~383 ha (≈11%)**, with remaining losses dispersed across **Kampot and Kep** as smaller, discontinuous parcels (MoE, 2025). The lower absolute rate compared with the 1997–2011 interval may reflect improved protection and co-management in some areas, but it may also partly reflect differences in methods and mapping thresholds; therefore, extent trends should be triangulated with field evidence on fragmentation, hydrologic change, and land conversion.

A4. Interpretation note

For the main chapter, it is best to report (i) the MoE 2014–2025 trend as the most current national mapping signal, and (ii) the NSOC 1997–2011 trend as historical context. These two together show a long-term decline with evidence of slower recent net loss, while emphasizing that "extent" alone does not capture degradation from hydrologic disruption, pollution stress, or fragmentation.

B) Coastal wetlands and estuarine systems (Ramsar complexes and livelihood dependence)

B1. What is included as “coastal wetlands”

Cambodia’s coastal wetlands include estuaries, tidal flats, mangrove-lined channels, brackish lagoons and associated floodplain mosaics. These systems provide core ecosystem services: filtering sediments and nutrients, buffering storm surges, supporting high nursery productivity for fisheries, and maintaining habitat for migratory waterbirds along the East Asian–Australasian Flyway.

B2. Peam Krasaop–Koh Kapik as the national flagship wetland complex

The **Peam Krasaop Wildlife Sanctuary** and the **Koh Kapik & Associated Islets Ramsar Site** form a connected mangrove–intertidal landscape recognized for international importance. The system’s productivity depends on the balance between **freshwater inflows** and **tidal exchange**, which maintains brackish conditions that support plankton production and fish recruitment. Intertidal flats and island channels are especially important for waterbird feeding and for small-scale fisheries (Ramsar Secretariat, 2012; Fauna & Flora, 2024).

B3. Livelihood linkage and sensitivity

Coastal wetland households around the Koh Kapik–Peam Krasaop system exhibit high dependence on wetland resources, meaning that changes in nursery function, salinity regimes or channel morphology can translate rapidly into income and food-security impacts. This is why wetland protection is not only a biodiversity priority but also a direct livelihood-risk management measure in Koh Kong.

B4. Community co-management and operational challenges

The Peam Krasaop wetland system includes community fisheries (CFis) that support participatory management and improve compliance where patrol resources and clear rules are sustained. Key operational challenges include (i) cross-boundary enforcement where parts of the Ramsar landscape extend beyond protected-area boundaries, and (ii) maintaining hydrologic connectivity where roads, embankments, canalization or shoreline works reduce tidal prism and alter flushing.

B5. Planning relevance (SCS SAP and integrated wetland management)

Under the SCS SAP, planning efforts emphasize integrated wetland management at local and regional levels, including management plans that align protected areas, fisheries zoning and community rules. Priority management themes typically include: maintaining tidal connectivity and freshwater inflows, preventing conversion of intertidal flats and mangrove edges, improving water-quality controls in upstream catchments, and sustaining community patrol capacity to deter illegal cutting and destructive fishing.

C. Selected site-specific status and pressures — expanded notes

C1. Site 1. Botum Sakor National Park (Koh Kong)

Status & ecological importance. Botum Sakor is a very large protected landscape following the 2023 reclassification (143,895 ha). Within its estuarine apron, peat-forming mangroves (~4,768 ha) sit over marine clay and contain deep organic soils, making them an exceptional **blue-carbon reservoir** and a high-value "natural infrastructure" for storm buffering. The defining feature is that peat stability depends on **continuous tidal exchange and high water tables**—once peat dries, oxidation and subsidence can cause long-lived carbon loss and weakened coastal protection.

Main pressures

- **Hydrologic restriction** from roads/embankments and undersized culverts can reduce tidal prism, trap sediments, shift salinity bands, and lower water tables—directly threatening peat integrity.
- **Concessionary development and associated access roads** increase fragmentation risk and accelerate edge effects (clearing, disturbance, easier entry).
- **Legacy charcoal production and local extraction pressure** can simplify stand structure and increase vulnerability to storms and erosion.
- **Poaching and wildlife disturbance** rise when access expands, undermining biodiversity values that support conservation legitimacy.

Management implications

- Apply a **"hydrology-first" rule**: protect tidal connectivity as the primary management objective in peat zones.
- Use **no-conversion cores** over peat tongues; treat drainage/canalization as "high risk" activities.
- Require **culvert/bridge sizing and maintenance** to maintain tidal exchange and water levels.
- Establish a simple compliance package: zoning map + signage + joint patrol priorities focused on peat blocks and tidal creeks.

Priority indicators

- Water level in peat-zone creeks, salinity in creek heads, canopy density/fragmentation, evidence of drainage/blocked culverts, and shoreline erosion/accretion near outlets.

C2. Site 2. Peam Krasaop Wildlife Sanctuary (Koh Kong)

Status & ecological importance. Peam Krasaop is a mangrove-dominated archipelago with strong tidal and upstream freshwater influence; it supports fisheries and livelihoods for local residents, and is now 16,982 ha after downsizing. The site contains multiple mangrove structural zones, indicating ecological gradients from intertidal flats through short-stature stands to taller riverine stands. Its key significance is **connectivity**: Peam Krasaop links with the Koh Kapik Ramsar system and nearshore habitats, forming one of Cambodia's most important mangrove–estuarine complexes for nursery functions and surge attenuation.

Main pressures

- **Water-quality and hydrology stress** from surrounding development: increased runoff, sediment, and nutrient inputs can reduce mangrove vigor and nursery productivity.
- **Aquaculture expansion and land conversion risk** can fragment mangroves and alter flushing patterns.
- **Transport infrastructure** can reshape channels and tidal exchange, affecting salinity and sediment budgets.
- **Localized extraction pressure** (fuelwood, small timber) can degrade accessible margins if not governed by community rules.

Management implications

- Manage Peam Krasaop as a **land–sea system**: zoning should protect tidal channels, intertidal flats, and mangrove edges that function as nursery corridors.
- Strengthen joint MoE–FiA coordination with adjacent community fisheries where access and livelihood uses are high.
- Prioritize low-cost measures that reduce chronic stress: buffer zones for runoff, control of clearing, targeted patrol support for community enforcement.

Priority indicators

- Channel/tidal connectivity, turbidity and nutrient proxies (simple water checks), mangrove fragmentation, and community catch/CPUE as a proxy for nursery function.

C3. Site 3. Koh Kapik & Associated Islets (Ramsar Site 998) (Koh Kong)

Status & ecological importance. Koh Kapik (~12,000 ha) is a Ramsar-designated wetland of alluvial islands, mangroves, and intertidal flats. A defining governance feature is that only ~60% falls inside Peam Krasaop WS while ~40% lies outside—so outcomes depend on **cross-boundary coordination**, not only sanctuary management. Ecologically, the system relies on freshwater inflows (Prek Koh Pao and Prek Khlang Yai/Stung Kep) mixing with tides to maintain brackish productivity that supports fisheries and waterbirds. The site also has high livelihood reliance (>65% of households with 70–90% wetland-derived income), so ecological change rapidly becomes a welfare issue.

Main pressures

- **Reduced freshwater inflow or altered timing** (upstream changes, diversions) can shift salinity and reduce plankton/fish productivity.
- **Channel infill/sedimentation** can shrink tidal prism and reduce habitat quality for shorebirds and fisheries.
- **Mangrove fragmentation** weakens storm buffering and nursery connectivity.
- **Cross-boundary enforcement gaps** (outside-WS areas) create weak points where clearing or unregulated activities can undermine the whole system.

Management implications

- Treat Koh Kapik as a **connectivity-managed Ramsar landscape**: protect inter-islet flats, keep channels open, maintain freshwater inflows, and coordinate rules across administrative boundaries.
- Prioritize simple "system integrity" protections (no conversion of flats, avoid blocking channels, maintain tidal prism).
- Link livelihood protection with management: community compliance improves when rules clearly protect fishing productivity.

Priority indicators

- Freshwater inflow proxies, salinity band shifts, channel width/depth condition (rapid field checks), intertidal flat condition, and community income/catch dependence as a sensitivity indicator.

C4. Site 4. Prey Nob District / Ream NP context (Preah Sihanouk)

Status & ecological importance. Ream National Park (~21,000 ha; ~6,000 ha marine) is a mixed habitat mosaic (mangroves, wetlands, seagrass, coral) surrounded by multiple communes and high human use. This makes it a "high interaction" protected area: management outcomes depend heavily on boundary compliance, land-based pollution control, and coordination with coastal development planning. Nearby mapping has recorded ~98 ha of seagrass in Prey Nob (2021–2022), and historical mangrove estimates around Ream are ~1,800 ha—useful signals of nursery habitat and coastal resilience values.

Main pressures

- **Habitat conversion and encroachment pressure** reflected in reported forest loss trends.
- **Rapid urbanization + port/tourism growth** increasing wastewater, runoff, and sedimentation loads that degrade nearshore habitats.
- **Shoreline works/dredging and coastal construction** that affect turbidity, seagrass light conditions, and estuary function.
- **Multiple users and access points** increase enforcement complexity and raise cumulative impacts (small activities add up).

Management implications

- Focus on **boundary integrity + land-based controls**: wastewater/drainage management and sediment control are as important as patrols.
- Use zoning to separate high-use areas (tourism/boat access) from sensitive seagrass/mangrove edges; apply no-anchor zones where needed.
- Strengthen collaborative governance with local authorities because pressures originate largely outside the park boundary.

Priority indicators

- Water-quality proxies (turbidity, coliform where feasible), seagrass extent and scarring, mangrove edge loss, and compliance indicators (patrol effort, violations).

C5. Site 5. Kampong Trach wetlands & Anlung Pring Protected Landscape (Kampot)

Status & ecological importance. Anlung Pring (~219 ha) is embedded in seasonal wetlands and rice mosaics and serves as an important dry-season refuge for key waterbirds (including Sarus Crane). Its ecological function depends on **seasonal inundation timing and shallow-water persistence**, which also supports local fisheries and wetland productivity.

Main pressures

- **Hydrologic modifications** (canals, small reservoirs, drainage) can shift inundation timing/depth and reduce habitat suitability.
- **Saline intrusion** can alter wetland vegetation and food availability and reduce freshwater productivity.
- **Landscape fragmentation** from agricultural intensification can reduce ecological connectivity across the wider wetland complex.

Management implications

- Protect the wetland's **seasonal water regime** (retain shallow-water dynamics; avoid drainage that eliminates dry-season refuges).
- Integrate wetland conservation into local land and water planning (align irrigation/drainage with biodiversity and fisheries needs).
- Use a small set of practical measures: water-level management rules, buffer strips, and community awareness on dry-season sensitivity.

Priority indicators

- Seasonal water depth/duration, salinity in dry season, waterbird counts, and local fish catch indicators.

C6. Site 6. Chumpu Khmao (Prey Nup)

Status & ecological importance. Chumpu Khmao is a community fishery (CFi) landscape within a broader coastal wetland system. Recent restoration planting (12,500 mangrove saplings) indicates active community stewardship. The area also has biodiversity significance (e.g., fishing cat records in the wider mangrove landscape), and it sits within a coastal corridor between major seagrass cells (Steung Hav and Kampot meadows), making it strategically placed for community-based monitoring and compliance.

Main pressures

- **Localized clearing and gear impacts** typical of multi-use wetlands (small but cumulative).
- **Water-quality stress** from nearby settlements/activities affecting mangrove and nearshore conditions.
- **Connectivity pressures** (if adjacent corridors degrade, the site loses nursery function and resilience).

Management implications

- Build on existing restoration by linking it to **enforceable CFi rules** (gear restrictions, no-cut zones, patrol support).

- Promote “simple, visible” management: signage, community patrol schedules, and reporting mechanisms for violations.
- Use the site as a **community monitoring node** for nearby seagrass (anchor management, trawl exclusion signals) and mangrove survival rates.

Priority indicators

- Mangrove seedling survival and canopy recovery, violations/patrol effort, and simple nearshore habitat checks (seagrass presence/scarring where relevant).

D. Data note

Mangrove “extent” figures differ by dataset and method; they are best interpreted as **trend signals** rather than exact totals. Wetland extent and condition are even less consistently quantified in legal instruments and often rely on Ramsar documentation, habitat mapping, and project assessments. For reporting, avoid mixing extent totals across incompatible sources and prioritize clarity on (i) the dataset used, (ii) the year, and (iii) the main uncertainty drivers (classification, tide, validation coverage).

Annex 4-6 Extended explanatory note on coral reefs and seagrass in Cambodia

(Supporting Sections 4.2.2.1 and 4.2.2.2 of the main chapter)

A. Coral reefs (status, distribution, and interpretation)

A1. Distribution and reef types

Cambodia’s coral reefs are predominantly **fringing reef systems** associated with island groups along the Gulf of Thailand. The highest concentration occurs around the **Preah Sihanouk archipelagos** (especially the Koh Rong Archipelago) and the **Koh Kong island complex** (including Koh Sdach and nearby island chains). Smaller reef patches are present along the mainland-influenced waters of **Kep and Kampot**, where higher turbidity favors sediment-tolerant reef assemblages and limits reef development to discontinuous, shallow patches. This spatial pattern reflects the interaction of (i) substrate availability around islands, (ii) sediment and nutrient loads from nearshore development and rivers, and (iii) wave exposure and circulation in the semi-enclosed Gulf.

A2. Extent and uncertainty (why figures vary)

Early national assessments estimated approximately **~2,700 ha** of reef habitat, largely concentrated in Koh Kong and Preah Sihanouk. More recent mapping and validation comparing **2014 vs. 2025** indicate that reefs remain strongly concentrated in **Preah Sihanouk and Koh Kong (>85% of national mapped cover)**, with changes over time generally described as **modest and method-bounded**—meaning that apparent gains/losses can partly reflect classification thresholds, sensor resolution, water clarity at image acquisition, and validation coverage rather than true ecological change. For this reason, reef “extent” should be interpreted alongside **condition indicators** (live coral cover, structural complexity, fish biomass) and **pressure indicators** (turbidity, fishing intensity, tourism footprint).

A3. Condition and ecological signals

Available evidence suggests that reef condition in the 2000s typically ranged from **fair to good** (≈23–58% live cover). Long-term monitoring in Koh Rong (initiated around 2010 and later extended to Koh Sdach and Kep) indicates reefs that are **sediment-influenced**, with benthic communities often dominated by **massive and encrusting genera** such as *Porites* and *Diploastrea*. This dominance is an important ecological signal: massive/encrusting forms are generally more tolerant of periodic turbidity and sedimentation, but their prevalence often coincides with **reduced branching coral abundance**, lower structural complexity, and altered fish assemblages over time. In practice, this means reefs can remain "alive" (moderate live cover) while still experiencing **structural simplification** and reduced nursery/refuge function for reef fish.

A4. Monitoring and comparability (CCRMN and why it matters)

Since 2019, the **Cambodian Coral Reef Monitoring Network (CCRMN)** has standardized protocols across sites for fish biomass, benthic cover, invertebrates, and structural complexity. This is important for two reasons:

1. It improves **comparability** across provinces and years (reduces "apples vs oranges" monitoring), and
2. It supports management evaluation—i.e., whether zoning/enforcement (MNPs, MFMAs, CFis) is associated with measurable improvements in fish biomass or reduced physical damage.

A5. Species diversity and data gaps

Cambodia likely hosts around **~70 coral species**, but distribution data remain incomplete—particularly offshore. Several historical/partner surveys have mapped nearshore reefs, but **species inventories** and **standardized biodiversity baselines** remain limited in many areas. Localized coral extraction persists in some communities, typically small-scale, but it can be significant where reef patches are small or already degraded.

A6. Management interpretation and priorities

The key management implication is that Cambodia's reefs are strongly shaped by **chronic, cumulative pressures** rather than single catastrophic events. Priority actions typically include:

- Reducing **sedimentation and water-quality stress** (shoreline works, dredging controls, wastewater/runoff management)
- Strengthening fisheries compliance (illegal gears, compressor fishing where relevant)
- Managing tourism impacts (anchoring, trampling, unregulated snorkel/diver pressure)
- Targeting restoration where it has the highest chance of success (e.g., reef areas with stable substrate, manageable turbidity, and enforceable no-anchor zones)

Recent mapping-based restoration priorities highlight **Koh Rong Sanloem/Prek Svay** (high tourism pressure) and larger Koh Kong reef complexes such as **Samros Koh Sdach, Phnhy Meas and Chrouy Pros**, reflecting a strategy of focusing on places with both ecological scale and practical management leverage.

B. Seagrass (status, distribution, and interpretation)

B1. Distribution and meadow configurations

Cambodia hosts extensive seagrass meadows, particularly in **Kampot and Koh Kong**, with notable nearshore beds also recorded around Preah Sihanouk coastal cells. Recent surveys describe two dominant configurations:

1. **Large mainland-adjacent meadows** (often shallow, continuous, and highly exposed to fishing and turbidity pressures), and
2. **Smaller island/bay patches** (more sheltered but vulnerable to localized tourism and anchoring).

Dominant taxa commonly include *Thalassia hemprichii*, *Halodule uninervis*, and *Enhalus acoroides*—a composition typical of shallow tropical Indo-Pacific meadows.

B2. Why seagrass matters (services and sensitivity)

Seagrass provides (i) **nursery habitat** that supports coastal fisheries productivity, (ii) **sediment stabilization** that improves water clarity and shoreline resilience, and (iii) important **blue-carbon storage** in below-ground biomass and soils. It is also the key feeding habitat for **dugongs** and foraging green turtles. However, seagrass is highly sensitive to two stress pathways:

- **Light limitation** (turbidity, suspended sediment, eutrophication-driven algal growth), and
- **Physical disturbance** (bottom trawling/push-nets, dredging, propeller scarring, anchor damage).

These pathways are critical because they link seagrass condition directly to manageable pressures: gear restrictions, dredging controls, and wastewater/runoff management.

B3. Mapped examples and extent (with caution)

Recent mapped examples (~2,333 ha across 11 sites) include **Chrouy Pros Bay (~1,485 ha)**, **Steung Hav (610 ha)** and **Prey Nob (98 ha)**, with smaller island patches (e.g., Koh Ta Kiev, Koh Bong, Koh Tang, Koh Thmei/Thmor Tom). These figures are valuable for spatial planning but should be treated as mapping-based extents that can vary with water clarity, seasonality, and classification thresholds. For management, it is often more useful to track:

- Meadow persistence (stable vs shrinking),
- Disturbance signatures (trawl scars, anchor scars), and
- Local light/turbidity trends in high-use corridors.

B4. Governance linkages (why MFMAs matter for seagrass)

A key feature of Cambodia's seagrass is that many major meadows occur **within or adjacent to MFMAs** and high-use nearshore corridors (fishing, tourism, port approaches). This makes fisheries zoning and enforcement (trawl bans, no-anchor zones, seasonal closures) one of the most direct levers for improving meadow condition—often more immediately than longer-term restoration planting.

C. Selected site-specific status and pressures — expanded notes

C1. Site 1. Koh Rong Archipelago (Koh Rong Marine National Park)

Designation and governance context. Koh Rong was initially managed under fisheries zoning (MFMA) and later designated as a **Marine National Park (Feb 2018)**. This governance transition creates a practical need for **MoE–FiA coordination** so that zoning boundaries, permitted activities, and enforcement roles are consistent for residents, fishers, and tourism operators.

Ecological status (reef and seagrass). Spatial planning baselines map approximately **~1,198 ha of coral reefs** and **~1,360 ha of seagrass**. Reef surveys in 2019–2020 recorded **~29.8% coral cover**, with communities dominated by sediment-tolerant *Porites* and *Diploastrea*, while fish biomass remains low—consistent with continuing fishing pressure.

Main pressures

- **Tourism growth** (anchoring, coastal infrastructure, beach development, trampling)
- **Dredging/shoreline works** and sediment plumes that reduce water clarity and stress seagrass
- **Fishing pressure** and gear impacts that suppress fish biomass and alter reef trophic structure

Management implications (priority actions)

- Establish and enforce **no-anchor zones** + install **moorings** in high-use bays
- Strengthen enforcement of **gear restrictions** and spatial closures
- Apply strict controls on **dredging/shoreline works** near sensitive seagrass and reef edges
- Use the CCRMN/partner monitoring to track outcomes (fish biomass, benthos, complexity)

C2. Site 2. Kep Archipelago (Koh Tonsay & Koh Pou) within the Kep MFMA

Status and ecological significance. The Kep MFMA (~11.3 thousand ha) encompasses reefs and some of Cambodia's largest seagrass meadows (**~6,399 ha**), making it nationally important for fisheries nursery services and blue-carbon potential.

Condition signals. While some reef pockets retain high coral cover (e.g., Koh Seh reported at ~64% live cover in 2019), many nearshore reefs are small and vulnerable to turbidity and physical disturbance. Seagrass condition is particularly sensitive to bottom-contact fishing and resuspension of sediments.

Main pressures

- **Illegal trawling and bottom-contact gears** (direct seagrass damage, sediment resuspension)
- **Electric fishing and destructive gears** (fish community impacts)
- **Sedimentation/turbidity** from coastal activities and nearshore disturbance

Management implications

- Maintain/expand **anti-trawl networks** and patrol effort focused on meadow margins
- Clarify MFMA zoning and restrictions in user-friendly formats (maps/signage)
- Prioritize seagrass condition monitoring (extent + scars) as the key performance indicator

C3. Site 3. Kampot Beach / nearshore Kampot (proposed MFMA)

Status. The most recent compilation reports a nearshore belt with **~5,158 ha seagrass (10 spp.)** and **~467 ha coral reef**, including a large single reef feature at **Nataya (~305 ha)**. A proposed **~8,486-ha MFMA** is intended to formalize zoning and enforcement in collaboration with three active CFis.

Main pressures.

- **Sedimentation and turbidity** (river plumes, shoreline works) reducing light availability
- **Gear impacts** (bottom-contact fishing) affecting meadow integrity
- **Incremental coastal development** increasing nutrient loads and physical disturbance

Management implications.

- The proposed MFMA offers the key mechanism to implement enforceable rules: trawl exclusion, gear restrictions, zoning for sensitive habitats, and community-supported patrols
- Pair zoning with basic water-quality controls (runoff/wastewater) to protect the light environment necessary for meadow persistence

C4. Site 4. Koh Sdach–Koh Kong Archipelago

Status and trend signal. Earlier surveys described good condition at some sites, but later assessments suggest increasing degradation signals over time. Current accounting indicates large contiguous reef areas embedded in **Samros Koh Sdach** and **Phnhy Meas**, which are practical focal zones due to their scale and connectivity.

Main pressures.

- **Fishing pressure and destructive/illegal gears**
- **Sedimentation/turbidity** in more mainland-influenced waters
- **Limited enforcement coverage** across dispersed island complexes

Management implications.

- Focus conservation investment on "high-leverage" reef blocks (largest contiguous areas) where enforcement and restoration pilots (transplantation/artificial structures) can be monitored and maintained
- Integrate reef protection with local fisheries management to improve compliance incentives

D. Data note

Mapping-based reef and seagrass extent figures are sensitive to methods (imagery, season, water clarity, classification thresholds). For management, pair extent maps with **condition indicators** (live coral cover, structural complexity, fish biomass; seagrass scars and light/turbidity proxies) and **pressure indicators** (trawl activity, dredging footprint, tourism intensity).

Annex 4-7 Explanatory note for Coastal area-based management: MPAs, Ramsar systems, MFMAs/EAFM, and community co-management

Protected areas, MFMAs and community management: Cambodia's coastal governance is implemented through a layered set of area-based instruments that combine MoE-managed protected areas and marine parks with MAFF/Fisheries Administration fisheries zoning (MFMAs) and community co-management. Table 4.xx summarizes the main MPAs and OECM-related measures discussed in this chapter and highlights where **habitat priorities (mangroves, wetlands, coral reefs and seagrass)** align—or potentially conflict—across different management instruments.

The table shows three major governance "clusters" where zoning coherence is essential. **First, Koh Kong's mangrove–wetland complex** is anchored by **Botum Sakor National Park (143,895 ha)** and **Peam Krasaop Wildlife Sanctuary (16,982 ha)**, with significant mangrove blocks (including **peat-forming mangroves**) and functional connectivity to the **Koh Kapik Ramsar system (~12,000 ha)** and the **Chrouy Pros seagrass area (~1,485 ha)**. In this landscape, coherent zoning is needed to safeguard hydrology, mangrove integrity, and nearshore fisheries habitat while balancing access and enforcement across adjacent designations.

Second, the **Preah Sihanouk coastal system** includes **Ream National Park (~21,000 ha)** with substantial mangrove/wetland values (mangrove **~6,500 ha**; wetland **~1,800 ha**) and adjacent nearshore use areas. Here, coherence depends on maintaining consistent rules between protected-area management and coastal development controls so that habitat protection is not undermined by land-based pressures.

Third, the **Kep–Kampot and offshore archipelago systems** are characterized by coral-reef and seagrass mosaics managed through both protected-area and fisheries instruments. **Koh Po and Koh Tonsay Archipelago (11,307 ha)** contains mapped reef and seagrass features (**67.83 ha reef; 3,900 ha seagrass**). The **Koh Rong seascape** illustrates the most important overlap issue: **Koh Rong MFMA (2016; 40,535 ha)** predates **Koh Rong Marine National Park (2018; 52,498 ha)**, and both aim to protect key habitats (reef **~1,198 ha**; seagrass **~1,360 ha**; plus additional reef values reported in the MFMA row). To avoid confusion and compliance gaps, MoE–FiA coordination is required to align **boundaries, zoning rules, permitted gears/activities, and enforcement responsibilities** within the shared seascape.

Community co-management underpins these systems by strengthening local compliance and stewardship, especially in inshore fisheries and mangrove blocks. Where community rules intersect with protected-area zoning or MFMA regulations, harmonized boundaries and clear user guidance (maps, signage, and agreed enforcement protocols) are essential to ensure that communities, tourism operators and fishers face a single, coherent spatial management framework.

Annex 5

Annex 5-1 Data Sources

Annex Table 5-1 National Data

Source	Coverage	Variables	Notes
Fisheries Administration (FiA), MAFF	2012–2024	Marine capture production (by province, gear); aquaculture output; vessel registration; licensing; MCS operations	Core national dataset; annual time-series used for production and spatial analysis
FiA Marine Fishing Vessel Census (2018)	National coastal provinces	Vessel numbers, size class, engine power, registration status	Main fleet-structure baseline
FiA Strategic Planning Framework 2025–2034	Policy	Governance, management priorities	Used for institutional interpretation
National Fisheries Law (2006)	Policy	Legal framework	Used for governance context

Annex Table 5-2 Regional & International Data

Source	Variables	Notes
FAO FishStatJ (1950–2022)	Capture production, aquaculture production, landed value	Basis for long-term national trend analysis
Sea Around Us (SAUP) (1950–2019)	Reconstructed catch; stock-status plots; MTI, FiB, PPR indices; subsidy estimates	Used for ecological and economic indicators
SEAFDEC Trawl & Resource Surveys (1966–2019)	Demersal CPUE, biomass proxies, species assemblages	Key baseline for biomass depletion
MaFReDI (2023)	Coastal CPUE monitoring	Complements SEAFDEC trend
Peer-reviewed literature	Ecosystem condition (reefs, seagrass, biodiversity)	Used for contextual validation

Annex 5-2 Indicator Metadata Tables

Production Indicators

Cambodia’s fisheries comprise inland, marine and aquaculture components, together contributing significantly to food security and rural livelihoods. Inland systems dominate national catch due to the Tonle Sap–Mekong flood-pulse system, while marine production—though smaller—remains central to coastal economies. Long-term expansion of motorized fleets, increased fishing effort and gear modernization have contributed to higher landings but also heightened ecological pressures. Aquaculture has emerged as a major contributor to national production, although marine and brackish components remain modest and concentrated geographically.

Aquaculture has grown rapidly since the early 2000s, dominated by freshwater pond and cage culture (≈95% of output). Marine and brackish aquaculture remain limited but strategic, focusing on groupers, seabass and shellfish in Koh Kong, Preah Sihanouk and Kampot. Coastal aquaculture has recently contracted due to land constraints, disease outbreaks, salinity change and rising operational costs. Climate stress (salinity intrusion, higher water temperature) and weak biosecurity further affect productivity. Expansion potential exists but requires improved planning, hatchery capacity and environmental safeguards.

Annex Table 5-3 Production Indicators

Indicator	Definition	Units	Data Source	Temporal Coverage
Total capture production	Combined inland + marine capture	tonnes/year	FAO; FiA	1950–2024
Marine capture (by province)	Marine landings by coastal province	tonnes/year	FiA	2012–2024
Aquaculture production	Freshwater, brackish, marine farmed output	tonnes/year	FAO; FiA	1976–2024

Annex 5-3 Explanatory note for marine catches by gear type

Cambodia's marine fisheries show a long-term industrialization trajectory. Gear composition indicates a transition from primarily small-scale and artisanal operations to a more mechanized, trawl-dominated sector after the mid-1980s, followed by moderate diversification with small-scale gears regaining share after 2005. The trawl share averaged 55–60% of marine catch, while purse seines averaged 30–35%. This gear composition aligns with broader regional trends in the Gulf of Thailand, where bottom-trawl and purse-seine fleets expanded rapidly and later plateaued due to overexploitation, fuel costs, and habitat degradation.

Trawl fisheries (bottom trawl & shrimp trawl): Trawling is the dominant gear in Cambodia's marine sector. From small beginnings in the 1960s (<1,000 tonnes), trawl catch expanded with mechanization to ~71,900 tonnes (1970), surged through the 1980s–1990s to 153,700 t (1990), and peaked at ~181,000 tonnes (2002). Since the mid-2000s it has plateaued around 118,000–138,000 tonnes, consistent with capacity saturation and tighter licensing/zoning. Trawl dominance coincided with rapid sediment resuspension and benthic degradation in coastal waters, particularly in Kampot and Koh Kong, with ecological implications for demersal stock recovery.

Purse-seine fisheries: Purse seining emerged in the mid-1960s (~10,400 t) and grew rapidly with synthetic nets and motors, climbing to ~37,100 t (early 1970s) and peaking near 191,500 t (2000) as small pelagics were heavily targeted. Since 2005, catches have moderated to ~53,000–67,000 t a year. This trend reflects both stock limitation of small pelagics and tighter FiA restrictions on encircling nets within 20 m depth zones.

Small-scale gears: Subsistence and artisanal fishing gears (gillnets, traps, handlines) rose from ~11,000–14,000 tonnes in the 1960s–1970s to ~47,000 tonnes in the mid-1980s, then stabilized around 15,000–18,000 t after 2000—about 10% of marine landings—remaining crucial for food security in provinces such as Kep and Kampot. Although quantitatively smaller, small-scale gears underpin food security and coastal livelihoods. Their persistence signals the resilience of artisanal sectors under industrial pressure.

Other Gears (longlines, handlines, traps, and unknown): Minor and variable, these gears collectively contributed less than 1% of national marine landings (e.g., 1,986 tonnes in 2019). Their presence reflects residual multi-gear operations in estuarine and reef zones, often tied to seasonal or subsistence activity.

Annex Table 5-4 Marine Catches by Gear Type in Cambodian Waters (tonne)

Year	Trawl	Purse seine	Small-scale gears	Others
1960			15,900	1
1961	964		26,237	2
1962	996		24,180	1
1963	1,034		17,786	2
1964	1,089		18,096	3
1965	26,479	10,448	11,609	0
1966	35,321	14,883	11,926	0
1967	43,991	18,814	12,246	0
1968	51,291	20,873	12,570	1
1969	58,958	23,206	12,897	3
1970	71,875	33,463	13,227	6
1971	80,486	33,790	13,561	4
1972	87,707	37,123	13,898	7
1973	74,207	35,186	14,239	7
1974	71,379	35,891	14,582	6
1975	69,967	37,889	1,493	7
1976	57,369	32,439	1,479	10
1977	67,315	43,224	1,465	7
1978	69,154	44,822	1,451	0
1979	64,043	43,410	1,435	0
1980	59,144	38,878	11,888	6
1981	74,097	53,839	16,622	35
1982	82,655	57,700	23,062	111
1983	88,293	71,940	30,317	190
1984	87,215	68,106	38,579	89
1985	95,021	75,984	47,519	145
1986	107,724	81,110	47,775	236
1987	131,685	96,714	47,498	543
1988	126,418	99,052	47,390	355
1989	133,176	101,253	46,655	460
1990	153,674	108,375	45,622	523

1991	149,627	110,901	44,231	600
1992	156,208	132,184	42,205	968
1993	156,035	128,059	41,608	778
1994	153,105	145,527	40,190	938
1995	158,694	148,784	38,439	932
1996	158,521	149,475	36,372	714
1997	156,602	148,708	33,800	448
1998	156,924	150,390	42,609	575
1999	172,586	183,898	30,423	1,305
2000	174,434	191,546	30,148	1,448
2001	177,634	173,241	28,500	1,434
2002	181,024	177,998	27,119	1,130
2003	180,536	168,557	24,992	1,560
2004	175,633	163,826	27,258	1,611
2005	176,611	161,134	24,637	1,930
2006	158,331	139,535	22,450	1,749
2007	152,662	134,268	19,854	1,875
2008	96,655	39,517	26,085	2,324
2009	104,295	45,002	15,442	1,434
2010	92,606	57,656	15,677	1,612
2011	114,197	66,367	15,876	1,744
2012	119,516	70,761	16,526	1,754
2013	111,572	56,554	16,747	1,810
2014	125,749	62,512	17,111	1,674
2015	119,318	58,021	17,397	1,694
2016	118,096	53,239	17,334	1,688
2017	118,362	53,555	17,607	1,714
2018	138,010	67,097	17,630	1,972
2019	128,483	63,634	17,644	1,986

Source: Sea Around Us (SAU), 2024. Catches by Gear in the waters of Cambodia

Annex Table 5-5 Aquaculture production & value (FAO).

Year	Aquaculture		Marine		Brackishwater		Freshwater	
	Tonnes - live weight	Value (USD 1000)	Tonnes - live weight	Value (USD 1000)	Tonnes - live weight	Value (USD 1000)	Tonnes - live weight	Value (USD 1000)
1976	4		0		0		4	
1977	11		0		0		11	

1978	25		0		0		25	
1979	53		0		0		53	
1980	106		0		0		106	
1981	240		0		0		240	
1982	464		0		0		464	
1983	934		0		0		934	
1984	1,610	2,543	0	0	0	0	1,610	2,543
1985	3,000	5,005	0	0	0	0	3,000	5,005
1986	2,200	3,933	0	0	0	0	2,200	3,933
1987	2,500	4,757	0	0	0	0	2,500	4,757
1988	4,600	9,356	0	0	0	0	4,600	9,356
1989	5,538	11,900	0	0	0	0	5,538	11,900
1990	6,400	13,943	0	0	0	0	6,400	13,943
1991	6,700	15,332	0	0	0	0	6,700	15,332
1992	8,550	18,869	0	0	0	0	8,550	18,869
1993	7,900	19,758	0	0	500	2,860	7,400	16,898
1994	8,200	20,694	0	0	560	3,248	7,640	17,446
1995	9,511	23,530	0	0	731	4,240	8,780	19,291
1996	9,600	23,252	0	0	600	3,480	9,000	19,772
1997	11,800	25,957	0	0	266	1,569	11,534	24,387
1998	14,100	28,847	0	0	1,515	2,764	12,585	26,083
1999	15,000	29,383	0	0	712	1,197	14,288	28,186
2000	14,430	28,275	0	0	428	656	14,002	27,618
2001	17,500	28,836	3,500	875	537	1,399	13,463	26,562
2002	18,250	27,510	3,650	913	467	803	14,133	25,795
2003	26,300	35,726	7,800	1,950	614	1,131	17,886	32,645

2004	37,515	40,935	16,840	4,210	775	1,285	19,900	35,440
2005	44,000	49,947	18,000	4,500	1,000	1,707	25,000	43,740
2006	41,010	62,241	6,810	1,703	1,400	1,968	32,800	58,570
2007	35,260	62,767	0	0	1,360	2,027	33,900	60,740
2008	40,000	70,470	1,560	3,815	90	450	38,350	66,205
2009	50,000	91,548	1,940	4,320	95	475	47,965	86,753
2010 (a)	60,000	112,570	2,120	5,060	100	500	57,780	107,010
2011	72,000	136,850	2,500	6,000	120	600	69,380	130,250
2012	74,000	144,530	2,810	6,380	160	800	71,030	137,350
2013	90,000	174,540	3,250	7,100	160	800	86,590	166,640
2014	120,055	226,143	4,350	9,600	170	850	115,535	215,693
2015	145,000	270,975	3,400	8,140	170	850	141,430	261,985
2016	172,500	321,303	9,744	20,476	1,053	5,265	161,703	295,562
2017	207,500	616,770	10,150	21,540	1,070	5,350	196,280	589,880
2018	254,050	754,210	12,160	24,670	1,280	6,400	240,610	723,140
2019	307,408	924,939	13,988	27,824	1,340	6,700	292,080	890,415
2020	400,400	1,209,505	18,000	34,720	1,720	8,600	380,680	1,166,185
2021	348,350	1,051,925	15,670	30,220	1,490	7,450	331,190	1,014,255
2022	330,600	998,865	14,890	28,810	1,400	7,000	314,310	963,055

Source: *FAO, 2024. FishStatJ.*

B2. Ecological Indicators

Ecosystem indicators show a persistent decline in trophic integrity and biomass. MTI trends reflect the loss of larger predatory species, while FiB signals decades of effort expansion compensated by exploitation of lower-trophic species. PPR values exceeding 2.0 during peak years indicate ecological footprints surpassing carrying capacity. CPUE declines (>80% since the 1960s) suggest substantial demersal biomass depletion. Habitat degradation—mangrove loss, seagrass decline, turbidity—further constrains recovery potential. Together, these indicators describe a system under high stress and low resilience.

Annex Table 5-6 Ecological Indicators

Indicator	Definition	Units	Method Source
Marine Trophic Index (MTI)	Mean trophic level of catch	Unitless	SAUP algorithm
Fishing-in-Balance Index (FiB)	Expansion/compensation index	Unitless	Pauly & Christensen (1995)
Primary Production Required (PPR)	PP needed to sustain fisheries	Fraction of PP	SAUP
Stock-status plots	Composition of developing/exploited/overfished/collapsed stocks	%	SAUP
CPUE (demersal)	Trawl catch per unit effort	kg/hour	SEAFDEC; MaFReDI

Annex 5-4 Explanatory note for Stock-status plots

Cambodia's marine fisheries have shifted from developing to heavily exploited conditions. The shift from green (Exploited) to orange/red (Over-exploited/Collapsed) means that over time, the Cambodian catch became increasingly dependent on unhealthy stocks. This is unsustainable and signals a fishery in crisis. The rise in the number of over-exploited and collapsed stocks confirms that the problem is not isolated. The entire marine ecosystem is under severe stress, with many distinct populations unable to sustain themselves. Based on the stock-status plots show in the graphs (**Error! Reference source not found.**), the history of Cambodian fisheries can be divided into three major phases.

- **Phase 1 – Developing phase (1950s–early 1970s):** Most marine stocks were in the Developing category, meaning fishing pressure was light and potential was still largely untapped. Over 95% of total catch came from developing stocks, indicating abundant resources and low exploitation levels.
- **Phase 2 – Exploited phase (1970s–1980s):** During the 1970s, the proportion of Exploited stocks rose sharply—from less than 1% in the mid-1960s to nearly 19% by 1970 and stabilizing around 10–12% through the early 1980 and —showing that fishing effort had expanded rapidly and many populations were being harvested near their sustainable limits. This period marks the transition from a largely developing fishery to one operating at full capacity.
- **Phase 3 – Over-Exploitation and collapse phase (~1980s–onward):** After 1990s, Over-exploited and Collapsed categories increased sharply while Developing stocks nearly disappeared. The share of over-exploited catches grew to about 10–15% by 2010, and collapsed stocks accounted for 5–6% by the late 2010s. Count-based indicators show that more than half of assessed stocks were already collapsed by 2018–2019. Although most landings still come from exploited demersal and pelagic species, this concentration masks widespread depletion and low recovery potential.

Overall, the stock trajectory signals a shift from underutilization to chronic overfishing and ecosystem stress. The near absence of developing or rebuilding stocks points to limited recruitment and recovery, underscoring the need for rebuilding plans, habitat restoration, and stricter trawl and bycatch management to sustain Cambodia's marine fisheries.

Annex 5-5 Explanatory note for Marine Trophic Index (MTI) and FiB index

MTI and the FiB trends, the data from SAUP –indicate that Cambodia's marine fisheries are now operating under heavy pressure with limited capacity for recovery. Without stronger stock rebuilding, habitat protection, and effort reduction measures, the long-term sustainability of the fishery and its supporting ecosystem remains at significant risk.

The Marine Trophic Index (MTI) in Cambodian waters reflects a long-term shift from balanced to simplified marine ecosystems. Between 1950 and 1960, the MTI remained high at around 3.83, suggesting a healthy and mature food web dominated by top and mid-level predators, with limited fishing pressure. From the early 1960s to the early 1990s, however, the MTI steadily declined, reaching 3.47 by 1992, indicating progressive depletion of large predatory fish and an increasing focus on smaller, lower-trophic-level species. This trend represents a clear case of "fishing down the marine food web." From the 1990s onward, the MTI became more volatile but remained lower, generally fluctuating between 3.50 and 3.57, with a slight improvement after 2010. This instability suggests an ecosystem increasingly reliant on short-lived and lower-trophic species, such as small pelagics and invertebrates. The recent mild increase may be associated with management interventions, improved enforcement, and reduced illegal, unreported, and unregulated (IUU) fishing activity in Cambodian waters. Overall, the long-term MTI decline demonstrates a reduction in ecosystem complexity and resilience, making the marine system more vulnerable to climatic and anthropogenic stressors.

The Fishing-in-Balance (FiB) Index presents a complementary narrative. During the 1950s, FiB values were near zero, reflecting a fishery in equilibrium with the ecosystem. The index then rose rapidly from the 1960s to the early 2000s, peaking at 2.97 in 2002, even as MTI declined. This combination indicates "fishing through the food web," where total catches were maintained by expanding fishing effort and targeting smaller, lower-trophic species to compensate for the loss of higher predators. After 2008, the FiB index dropped sharply—down to 2.08 by 2010—and remained volatile thereafter. This decline signals that the expansion strategy had reached its ecological limit: the marine ecosystem could no longer sustain high catches, even from lower levels of the food chain.

Therefore, the data strongly indicates that the ecological health of Cambodian waters has **significantly declined** over the past 70 years. The marine ecosystem has been fundamentally altered by fishing pressure. The recent volatility in the indices, especially the sharp drop in FiB, is a red flag. It suggests that the current level of fishing effort may be unsustainable, and the long-term health of the fishery and the ecosystem it depends on is at risk without significant management interventions aimed at rebuilding fish stocks and restoring ecosystem balance.

Annex 5-6 Explanatory note for Number of marine fishing vessels

FiA conducted a marine fishing vessel census in 2018 to gather data on the characteristics of the fishing fleet. The census provides a foundational dataset used for various monitoring and management purposes, but specific statistics from the final report, such as the total number of vessels, are not immediately available in the provided search results. The census recorded 7,552 marine fishing vessels across its four coastal provinces, reflecting a predominantly small- to medium-scale fleet structure. The majority of vessels (about 53 %) were classified as small-scale (< 12 m), while 47% fell within the medium-scale range (12–24m). Only 10 vessels exceeded 24 m, highlighting the limited presence of large industrial craft in national waters. The census showed strong geographic concentration: Koh Kong accounted for 45 % of all vessels (3,396 units), followed by Preah Sihanouk (33 %, 2,523 units), Kampot (14 %, 1,039 units), and Kep (8 %, 594 units). Koh Kong's predominance reflects its extensive coastal area and long-standing trawl and gill-net fleets, while Preah Sihanouk's share corresponds to its role as Cambodia's principal marine landing hub and industrial port. Kampot and Kep, by contrast, remain more artisanal and seasonally active, focusing on crab, squid, and small-pelagic fisheries.

Fleet characteristics by size and power: Vessel classification by engine power confirms the small-scale character of the fleet: approximately 6,699 vessels (89 %) were under 50 HP, with only a small minority exceeding 90 HP. This pattern suggests limited offshore capability and strong dependence on coastal and inshore fishing grounds. The few higher-horsepower vessels (181–540 HP) are mainly trawlers and purse-seiners operating from Koh Kong and Preah Sihanouk.

Registration and management: Of the 7,552 vessels enumerated, 97% were non-registered, and only 3% held valid registration. This extremely low compliance rate underscores persistent governance challenges, including inadequate enforcement capacity, outdated vessel records, and the prevalence of informal operations. The predominance of unregistered craft complicates management of fishing effort and hinders the implementation of licensing and monitoring systems essential for sustainable fisheries management.

Indeed, the 2018 census provides the first comprehensive snapshot of Cambodia's marine fleet, revealing a sector dominated by small-engine, non-registered vessels clustered in Koh Kong and Preah Sihanouk. While this structure supports local livelihoods and employment, it also poses significant management and sustainability concerns. The combination of high vessel density, limited registration, and low engine power reinforces the need for targeted governance reforms, particularly vessel licensing, gear regulation, and enforcement coordination among coastal provinces.

Annex Table 5-7 Number of Marine Fishing Vessels: Large, Medium and Small Scale

Vessel Type (Ranking m)	Koh Kong	Preah Sihanouk	Kampot	Kep	Total
Large Scale (≥ 24 m)	10	0	0	0	10
Medium Scale (12 ≤ 24)	962	1,545	629	367	3,512
Small Scale (< 12 m)	2,424	978	410	227	4,030
Total	**3,396**	**2,523**	**1,039**	**594**	**7552**
Type of Engine Power (HP)	**Koh Kong**	**Preah Sihanouk**	**Kampot**	**Kep**	**Total**
< 50	2,967	2,115	1,028	589	6,699
51 – 90	157	110	7	7	279
91 – 180	179	257	4	0	440
181 – 270	57	26	0	0	83
271 – 540	36	15	0	0	51
Total	**3,396**	**2,523**	**1,039**	**594**	**7552**
Type of Engine Power (HP)	**Koh Kong**	**Preah Sihanouk**	**Kampot**	**Kep**	**Total**

< 50	2,967	2,115	1,028	589	6,699
51 – 90	157	110	7	7	279
91 – 180	179	257	4	0	440
181 – 270	57	26	0	0	83
271 – 540	36	15	0	0	51
Total	**3,396**	**2,523**	**1,039**	**594**	**7552**
Registration Status	**Koh Kong**	**Preah Sihanouk**	**Kampot**	**Kep**	**Total (%)**
Non-Registered	3,217	2,469	1,039	593	7,318 (79%)
Registered	191	41	2	0	234 (3%)
Total	**3,408**	**2,510**	**1,041**	**593**	**7,552**

Source: FiA, MAFF. Marine Fishing Vessel and Licensing Database.

Annex 5-7 Assessment methods (by indicator)

A. Production & Value Indicators

- **Trend detection:**
    - CAGR and decadal comparison
    - Baseline periods: 1960s, 1990s, 2010s
- **Normalization:**
    - Harmonised FAO & FiA series
- **Spatial breakdown:**
    - 4 coastal provinces
    - Marine share of national capture

B. Ecological Indicators

Marine Trophic Index (MTI)

- Computed from SAUP species–trophic-level data
- Interpreted as proxy for ecosystem complexity and predator loss

Fishing-in-Balance (FiB)

- $FiB = \log(Ct / (C_0 \times TE\text{\^{}}(TL_0 – TLt)))$
- Indicates “fishing through/exhausting the food web”

Primary Production Required (PPR)

- PPR = Σ (Catch × PPR coefficient)
- Interpreted as ecological footprint vs. carrying capacity

CPUE (Biomass Proxy)

- Standardized trawl-survey CPUE compared across decades
- Interpreted as index of demersal fishable biomass

Stock-Status Plots

- Categorization: developing / exploited / overexploited / collapsed
- Tracks long-term shift in stock health

C. Fleet, Gear & Economic Indicators

- **Fleet capacity:** number × engine class × registration share
- **Gear pressure:** trawl %; purse-seine %; small-scale contribution
- **Subsidy incentives:** capacity-enhancing vs. management-support ratio

D Cross-Linkage Analysis

Indicators were interpreted together to assess:

- ecological–economic decoupling
- habitat–fleet interactions
- transboundary footprint (foreign fleets in PPR patterns)
- combined climate–fishing pressures

Annex 6

Annex 6-1 Data Sources, Metadata, Assessment Method, and Explanatory Text

A. Economic and Policy Drivers

This annex summarizes the macro-economic and policy conditions that shape pressures on Cambodia's coastal and marine environment as well as the country's capacity to respond. It draws on long-term economic indicators from the World Bank WDI (2000–2024), national budget documents, and sustainable-finance initiatives to understand how GDP growth, investment flows, and fiscal space interact with coastal development trajectories. Particular attention is given to **gross fixed capital formation (GFCF)** and **foreign direct investment (FDI)**, which influence construction-driven pressures in coastal zones, including SEZ expansion, port development, and tourism infrastructure.

The annex also reviews Cambodia's **public financial architecture** for environmental governance, including annual budget allocations to fisheries law enforcement, protected areas, and biodiversity conservation. These data help determine whether current fiscal commitments are adequate relative to the scale of ecological degradation. The **MEF PPP pipeline** is evaluated to understand the alignment of proposed and ongoing public–private partnerships with ICZM, marine spatial planning, EIA/SEA requirements, and sustainability safeguards.

Finally, the annex integrates poverty headcount data and vulnerability metrics to identify how macroeconomic trends translate into distributional outcomes for coastal households. This is essential for assessing whether economic growth is increasing resilience or reinforcing livelihood precarity. Together, the indicators provide an evidence base for assessing Cambodia's long-term readiness for **blue-economy investment**, sustainable financing instruments, and equitable coastal development.

Annex Table 6-1 Economic and Policy Drivers: Data Sources, Metadata, and Assessment Method

Category	Details
Data Sources	• World Bank WDI (GDP, GFCF, FDI, CA balance, inflation, unemployment) • National budget documents (biodiversity, fisheries enforcement, NPASMP costing) • MEF PPP pipeline (solicited/unsolicited projects, VGF status) • Sustainable finance initiatives (CSFP, NBC–IFC taxonomy, CGCC guarantees)
Metadata	• GDP (current US$, annual % change), 2000–2024 • FDI inflows (current US$ and % GDP) • GFCF (current US$ and % GDP) • Poverty headcount (national poverty lines and US$1.90/day) • Budget allocations to fisheries, enforcement, and PA systems
Assessment Method	• Evaluate macroeconomic conditions shaping coastal development pressures. • Determine fiscal space and readiness for blue-economy financing. • Assess alignment of PPP projects with ICZM, MSP, and EIA/SEA obligations. • Link poverty and vulnerability data to coastal resilience and social-justice outcomes.

Cambodia's macroeconomic drivers—strong GDP growth, high FDI concentration in coastal SEZs, and rising GFCF—continue to intensify land-use change, port expansion, and tourism pressure in coastal provinces. Limited fiscal space and modest allocations for fisheries and PA management constrain the transition toward sustainable blue-economy investment, while persistent poverty pockets reduce household adaptive capacity.

Annex Table 6-2 Summary of Cambodia's key economic indicators (2020-most recent)

Year	GDP (current US$) - Billions	GDP (annual % of change)	GDP per capital (current US$)	Inflation rate, (average consumer prices)	Unemployment, total (% of total labor force) (modeled ILO estimate)	Current account balance (% of GDP)
2000	3.69	9.99	296.43	-0.79	0.74	-3.68
2001	4.15	7.39	327.50	-0.60	0.77	-2.12
2002	4.50	6.27	350.15	0.21	0.85	-2.38
2003	5.05	10.28	386.69	0.94	0.91	-4.63
2004	5.88	9.46	444.20	4.32	1.00	-3.11
2005	7.07	13.30	525.80	6.62	1.06	-4.34
2006	8.35	10.94	612.25	5.81	1.15	-2.80
2007	10.13	10.40	731.69	8.71	1.26	-4.18
2008	12.17	7.48	866.28	24.10	0.83	-6.74
2009	12.50	4.07	875.75	-1.24	0.58	-5.93
2010	13.81	5.08	952.27	4.00	0.77	-7.10
2011	16.03	7.29	1088.98	5.48	0.58	-6.40

2012	17.83	7.65	1192.80	2.93	0.50	-6.80
2013	19.81	7.86	1305.66	2.94	0.44	-6.54
2014	22.04	8.00	1431.56	3.86	0.69	-6.55
2015	24.17	7.21	1547.32	1.22	0.39	-6.61
2016	26.56	7.91	1675.20	3.02	0.72	-6.53
2017	29.36	8.08	1826.35	2.91	0.14	-6.16
2018	33.15	8.78	2036.67	2.46	0.13	-8.74
2019	36.69	7.94	2225.88	1.94	0.12	-8.00
2020	34.82	-3.56	2081.74	2.94	0.17	-1.00
2021	36.79	3.09	2167.40	2.92	0.40	-29.61
2022	39.99	5.13	2325.03	5.34	0.23	-18.96
2023	42.34	5.01	2429.75	2.13	0.23	1.30
2024	46.35	6.02	2627.88	…	0.27	0.48
2025	…	4.00	…	…	…	…

Sources: World Bank Group, Cambodia Data (WDI). Accessed 2025.

Annex Table 6-3 PPP Projects (Solicited & Unsolicited Projects)

Project title	Sector	Implement agency	Location	Cost (USD)	Status
A) Solicited Projects					
Agro-Industrial Park (AIP) in Kratie Province	Agro-Industrial Park	MEF	Kratié	170 million	Phase II
Establishment of New Ratanakiri Airport	Aviation	State Secretariat of Civil Aviation	Ratanakiri	96 million	Phase I
Establishment of Wholesale Market in Cambodia	Trade	Ministry of Commerce	Cambodia	-	Phase I
Mekong River Waterway Improvement Project from Kampong Cham to Kratie	Transportation	MPWT	Kratié	-	Phase I
Developing a Chhlong Tourism Port	Tourism	MPWT	Kratié	-	Phase I
Developing a Multi-Purpose Port	Transportation	Phnom Penh Autonomous Port	Kratié	-	Phase I
Green Special Economic Zone	Special Economic Zone	MEF	Cambodia	400 million	Phase II
Sihanoukville Smart Parking	Transpotation	Preah Sihanouk	Preah Sihanouk	11.8 million	Phase III

		Administrati on			
Kampot International Tourism Port	Tourism	MPWT	Kampot	9.27 million	Phas e V
Electric Buses in Siem Reap City	Transportatio n	MPWT	Siem Reap	26.8 million	Phas e II
Prey Kabas Irrigation Systems	Irrigation System	Ministry of Water Resources and Meteorolog y	Kandal, Takeo	11.4 million	Phas e II
Sihanoukville Logistics Complex	Logistics	MPWT	Preah Sihanouk	264 million	Phas e II
B) Unsolicited Project					
Funan Techo Canal	Transportatio n	MPWT	Kandal, Takeo, Kampot, Kep	1,156 million	Phas e V
Phnom Penh-Siem Reap-Poi Pet Expressway	Transportatio n	MPWT	Siem Reap, Banteay Meanchey	-	Phas e III
Provision of Aviation Security Services	Aviation	State Secretariat of Civil Aviation	Cambodia	5 million	Phas e V
Phnom Penh Logistics Complex	Logistics	MPWT	Phnom Penh	340 million	Phas e IV
Phnom Penh-Bavet Expressway	Transportatio n	MPWT	Kandal, Prey Veng, Svay Rieng	1,380 million	Phas e V
Development of New Mondulkiri Airport	Aviation	State Secretariat of Civil Aviation	Mondulkiri	-	Phas e III
Phnom Penh-Sihanoukville Expressway	Transportatio n	MPWT	Kandal, Kampong Speu, Koh Kong, Preah Sihanouk	1,897 million	Phas e V

Source: General Department of Public-Private Partnerships (GDPPP)/ MEF. https://ppp.mef.gov.kh/projects/solicited-projects. **Note:** *Phase I: Project Identification and Selection; Phase II: Project Preparation and Appraisal Phase III: Project Approval; Phase IV: Contracting Phase V: Management of PPP Contract.*

C. Institutional Setting

This annex maps the institutional architecture governing Cambodia's coastal and marine environment. It compiles the mandates of national bodies—such as NCSD, MoE, FiA/MAFF, MPWT, MLMUPC, MME, and MoT—through relevant Royal Decrees and sectoral laws. The analysis assesses whether existing institutional arrangements collectively cover the full range of land–sea interface issues, including fisheries, biodiversity, pollution control, maritime transport, land-use planning, and disaster preparedness.

A second dimension evaluates the **degree of coordination**, both vertical (national–provincial–local) and lateral (across sectors). SDG indicators 6.5.1 and 6.5.2 provide benchmarks of integrated water resources management and transboundary cooperation. The annex also examines key regional platforms (COBSEA, PEMSEA/SDS-SEA, ASEAN DRR) to understand Cambodia's participation in joint planning, marine litter action, and oil-spill contingency efforts.

Operational capacity is assessed using FiA and PCCMD monitoring systems, patrol logs, MPA/ Marine Fisheries Management Area (MFMA) management data, and laboratory/equipment inventories. These indicators help clarify whether institutions have the financial, technical, and human resources necessary for effective coastal governance. The annex highlights remaining gaps, including limited MSP formalization, oil-spill response readiness, data integration, and sustained O&M funding.

Annex Table 6-4 Institutional setting: data sources, metadata, and assessment method

Category	Details
Data Sources	• NCCMD Royal Decree (2012); NCSD Royal Decree (2015) • Line ministry mandates (MoE, FiA/MAFF, MPWT, MME, MoT, MLMUPC) • SDG 6.5.1 (IWRM 62% in 2023); SDG 6.5.2 (98% transboundary arrangements) • Regional platforms: COBSEA, SDS-SEA/PEMSEA, ASEAN DRR • FiA monitoring systems and PCCMD operational data
Metadata	• Institutional mandates and degree of formalization • Existence of vertical and lateral coordination mechanisms • Presence of monitoring systems (catch data, patrol logs, MPA/MFMA systems)
Assessment Method	• Determine whether institutions cover all coastal–marine governance functions. • Assess vertical (local–provincial–national) and lateral (sectoral) integration. • Evaluate operational readiness (financing, O&M, patrol assets, labs). • Identify gaps in oil-spill contingency planning and MSP formalization.

The institutional landscape covers most marine–coastal issues but remains weakly integrated, with significant coordination gaps between national, provincial, and community levels. Operational readiness is uneven: FiA and MoE have structured mandates but lack sufficient financing, O&M budgets, patrol assets, and laboratory capacity to deliver consistent enforcement and monitoring across all coastal provinces.

C. Legal and Policy Setting

This annex reviews Cambodia's legal and policy frameworks governing environmental protection, natural resources management, climate change, and coastal development. It maps both international commitments (Basel, Stockholm, CBD, CITES, Ramsar, UNFCCC/Paris, BBNJ) and domestic legal instruments (Environment Code 2023, Fisheries Law, Protected Areas Law, Water Law, Land Law). The analysis clarifies ratification status, reporting obligations, and the degree of legal alignment with global standards.

A central focus is whether Cambodia's laws enable **ecosystem-based management (EBM)**, **marine spatial planning (MSP)**, and integrated land–sea approaches. This includes examining the completeness of policy cycles—from data collection and decision-making to implementation and review—and the effectiveness of key implementing regulations such as the EIA/SEA framework and coastal development circulars.

The annex also evaluates the enforcement architecture: penalties and sanctions, licensing procedures, monitoring responsibilities, and the institutional ability to apply laws in practice. This helps identify gaps where legal instruments exist but lack operational mechanisms, or where emerging issues (e.g., marine litter, climate resilience, offshore activities, oil-spill responsibilities) are not yet fully covered.

Annex Table 6-5 Legal and policy setting: data sources, metadata, and assessment method

Category	Details
Data Sources	• International conventions: Basel, Rotterdam, Stockholm, CBD, CITES, UNFCCC, Kyoto, Paris, Ramsar, BBNJ • Domestic laws: Environment Code (2023), Fisheries Law, Protected Areas Law, Water Law, Land Law • National plans: CCCSP 2024–2033, Circular Strategy on Environment, NPASMP, fisheries strategies • EIA/SEA frameworks; Circular No. 01/2012 (coastal development)
Metadata	• Ratification status and reporting obligations • Sectoral legislation and implementing regulations • Degree of policy-cycle completeness (data → decision → implementation → review)
Assessment Method	• Review alignment of domestic law with international commitments. • Assess whether legislation enables EBM, MSP, and integrated coastal management. • Evaluate strength of enforcement mechanisms and regulatory tools. • Confirm regularity and effectiveness of policy reviews.

Cambodia has ratified most major environmental conventions and updated key domestic laws (Environment Code 2023, PA Law), but the enabling regulations and enforcement mechanisms needed for ecosystem-based management and MSP remain only partially implemented. Policy-cycle reviews are irregular, and areas such as marine litter, coastal zone planning, offshore activities, and oil-spill liability require clearer legal provisions and operational guidance.

Annex Table 6-6 Coastal–marine related legal and policy frameworks

Instrument	Status (year)	Lead / Compet ent Authorit y	Scope & relevance to coastal–marine	Implementation /notes
A) International Conventions & Agreements				

Basel Convention	Party (2001)	MoE (hazardous waste); Customs	Control of transboundary movement/disposal of hazardous waste; prevents coastal dumping/legacy contamination	National EIA/permits reference Basel lists; supports port & SEZ waste controls.
Rotterdam (PIC)	Party (2013)	MoE; MAFF	Prior informed consent for hazardous chemicals/pesticides that reach coasts via rivers & cities	Underpins pesticide/chemical import control and coastal run-off management.
Stockholm (POPs)	Party (2006)	MoE	Phase-out of POPs that bioaccumulate in marine food webs	National plans target legacy POPs; relevance to seafood safety.
CBD	Party (1995)	MoE/NCSD	National biodiversity strategies, PA systems, ABS; applies to reefs, seagrass, mangroves	Provides policy basis for MPAs & species measures.
CITES	Party (1997)	MAFF/FiA; Customs	Regulates trade in listed marine species (e.g., sharks, seahorses)	Permits & seizures guide; complements MFMA enforcement.
UNFCCC & Paris	Party (1995); Party (2017)	NCSD/MoE	Climate mitigation/adaptation; coastal resilience finance	Frames NDCs; enables coastal NbS & resilient ports investment.
Kyoto Protocol	Party (2002)	NCSD/MoE	GHG commitments (legacy)	Historical context for sector MRV.
Ramsar	Party (1999)	MoE	Wetlands of Intl. Importance (e.g., Koh Kapik)	Legal hook for mangrove conservation and restoration.
UNCLOS	Signature (1983); domestic ratification incomplete	MFAIC with line ministries	Maritime zones/rights, marine environment obligations	Legal gap noted in diagnostics; priority for completion.
BBNJ (High Seas Treaty)	Signed 9 Jun 2025; Ratified 6 Sep 2025	MFAIC/NCSD/MoE	ABNJ area-based tools, EIA, MGR benefit sharing	Signals global ocean governance engagement.
B) Regional Cooperation & Frameworks				
PEMSEA SDS-SEA & ICM	Ongoing program	MoE/PEMSEA Nat'l Focal	ICM across entire 435-km coastline; SDS-SEA 2023–2027 priorities (pollution, biodiversity, climate)	Platform for MSP/ICM peer support & training.

COBSEA RAP-MALI	Regional action plan (2019–)	MoE/NCSD	Marine litter prevention, control, cooperation	Aligns with national anti-plastic campaigns; port reception.
COBSEA Marine & Coastal Ecosystems Framework / Strategic Directions 2023–27	Guidance & workplan	MoE/line agencies	Ecosystem conservation, governance, cross-cutting enablers	Reference for regional best practice & projects.
Gulf of Thailand Oil Spill Framework	Cooperative mechanism	MPWT (competent authority)	Joint preparedness & response	Complements national contingency plan (draft).
ASEAN MoU on Joint Oil Spill Preparedness & Response (2014)	ASEAN mechanism	MPWT	Regional mutual aid and drills	Supports tiered response readiness.
C) National Laws & Core Regulations				
Code on Environment & Natural Resources	In force (2023)	MoE	Modernizes EIA/SEA, participation, compliance; cross-sector environmental governance	Foundational for MSP, marine pollution control, disclosure.
Law on Fisheries	In force (2006; with later amendment)	MAFF/FiA	Fisheries management; CFis; MFMAs; enforcement	Legal basis for MFMA network & co-management.
Protected Areas Law	In force (2008)	MoE	PA system, zoning, management	Applied to Koh Rong MNP & coastal PAs.
Water Resources Law	In force (2007)	MOWRAM	Basin/IWRM principles affecting land–sea flows	Links to SDG 6.5.1 progress.
Forestry Law	In force (2002)	MAFF/FA	Mangrove/forest governance	Relevant to coastal mangrove belts.
Land Law	In force (2001)	MLMUPC	Tenure/registration incl. coastal lands	Interface with PA/MFMA zoning & concessions.
Royal Decree – NCCMD	In force (2012)	MLMUPC (Chair)	National coastal coordination/ICM	Sub-decree under preparation to extend to marine waters.
Royal Decree – NCSD	In force (2015)	NCSD	Cross-gov't sustainability & reporting	Coordinates NDC/NBSAP and SDG reporting.
D) Site-Specific Marine/Coastal Instruments (EAFM/MPA)				

Koh Rong Archipelago MFMA	Prakas No. 364 (2016)	FiA/MAFF	First large MFMA (~405 km²) around Koh Rong/Samloem	Co-management; basis for gear/zone controls.
Koh Rong Marine National Park	Sub-Decree No. 14 (2018)	MoE	52,498 ha (inshore + offshore)	Active management; METT improving.
Kep: Koh Po & Koh Tonsay MFMA	Prakas (2018)	FiA	Habitat & fisheries protection	Supports small-scale fisheries & tourism.
Prek Kampong Smach MFMA (P. Sihanouk)	Prakas (2022)	FiA	10,923 ha	Expands coastal coverage; needs enforcement resourcing.
Peam Krasop Wildlife Sanctuary zoning	Sub-Decree 179 (2011)	MoE	Zonation (core, conservation, SUZ, community)	Mangrove nursery protection and community use.
Koh Kapik & Associated Islets	Ramsar Site (1999)	MoE	12,000 ha mangrove-delta	International protection & restoration anchor.
Proposed: Koh Sdach MFMA	In designation process	FiA + FFI	16,158 ha biodiversity & fishing grounds	Requires formal gazettal & budget.
Proposed: Kampot MFMA	Concept with WEA/MCC/CFis	FiA + partners	Seagrass, coral, marine mammals	Threats: reclamation, IUU; proposal under review.
Proposed: Koh Kong Krao MNP	Concept	MoE + FFI	Largest Cambodian island & coastal complex	Studies commissioned; progress slow.
E) Policies, Plans & Circulars				
National Protected Area Strategic Management Plan	2017–2031	MoE	System-wide PA management targets (incl. coastal parks)	Costed actions; needs sustained financing.
Strategic Planning Framework for Fisheries (update)	2015–2024	FiA/MAFF	Sector strategy incl. conservation, CFis, value chains	Basis for MFMA rollout & enforcement priorities.
Action Plan for Sea Turtles	2016–2026	FiA/partners	Species & habitat protection in coastal waters	Education, by-catch mitigation.
Circular No. 01 on Coastal Development	2012	RGC (MLMUPC-led)	Principles for coordinated coastal planning	Guidance without strong enforcement “teeth.”
Circular Strategy on Environment	2023–2028	NCSD/MoE	Cross-gov’t environmental priorities; circular economy	Aligns with Pentagonal Strategy Phase 1.
Cambodia Climate	2024–2033	NCSD/MoE	Adaptation/mitigation incl. coastal resilience	Framework for NDC3.0 delivery.

Change Strategic Plan				
NDC 3.0	Latest submission	NCSD/MoE	Raises ambition; adaptation for coasts	Guides finance pipelines (NbS, wastewater, ports).
Draft Marine Spatial Plan (EEZ)	Drafting stage	MoE (with NCCMD)	Spatial zoning of uses/pressures	Referenced in national & PEMSEA reports.
National Oil-Spill Arrangements & Dispersant Guideline	Drafting stage	MPWT (competent); MoE	Preparedness/response; port reception	Technical workshops done; formal adoption pending.
Statement No. 01 – Marine Fisheries Principles	2019	RGC	Vision for sustainable small-scale fisheries	Policy signal for MFMA and equity focus.
Sub-Decree on Water Pollution Control (No. 27)	1999	MoE	Establishes discharge standards, permitting and monitoring requirements for wastewater and effluent	Foundational instrument for controlling industrial, municipal and port-related discharges; enforcement capacity remains uneven.
Sub-Decree on Solid Waste Management (No. 113)	2015	MoE	Regulates solid waste generation, collection, transport and disposal	Provides legal basis for municipal and industrial waste management; challenges persist in coastal towns and tourism areas.
National Policy on Waste Management	2018	MoE	Sets national direction for integrated solid waste management	Supports improved collection, disposal and reduction of leakage to rivers and coastal waters.
National Action Plan for Marine Plastic Waste Management	2023–2030	MoE / NCSD	Targets reduction of plastic leakage into marine and coastal environments	Emphasises source reduction, awareness, recycling and inter-agency coordination; aligns with regional marine debris initiatives.
F) Data Systems, Monitoring & SDG Governance Indicators				
FiA Marine Catch Monitoring (landing sites)	Operational since 2021	FiA/MAFF	Monthly CPUE, effort, species, value for Kampot, Kep, Koh Kong, Preah Sihanouk	Inputs to EAFM, stock assessments, MFMA zoning.

SDG 14.6.1 (IUU instruments)	FAO scoring	FiA/MAFF, MoJ, Navy/NCMS	Tracks adoption/enforcement of IUU tools	Use FAO portal & UN metadata bands 1–5.
SDG 14.2.1 (Ecosystem-based approaches)	Qualitative evidence	MoE/FiA/NCCMD	Recognizes EAFM/MPAs/ICM as EBAs	Aggregate from MFMA/PA/ICM instruments.
SDG 6.5.1 / 6.5.2 (IWRM & transboundary)	62% (2023) / 98% coverage	MOWRAM/NCSD	Land–sea planning, Mekong cooperation	Indicates enabling environment but finance/capacity gaps.

D. Civil Society, Stakeholders and Participation

This annex synthesises the roles and contributions of civil society organisations, community groups, and other stakeholders in coastal and marine governance. It draws on NGO conservation program documents (FFI, MCC, WEA, WCS, IUCN), co-management agreements, SMART/Kobo field monitoring, and participation records from PCCMD, FiA, and MoE processes.

The analysis assesses the **breadth and depth of engagement**, mapping how many actors are involved, in what capacity, and with what degree of influence over planning and enforcement. Special attention is paid to **inclusion and social equity**—specifically, the extent to which women, youth, Indigenous people, and marginalized households participate in marine resource decision-making.

The annex evaluates the functioning of co-management structures (CFi, CPA, MFMA committees), their geographic coverage, resourcing, and effectiveness in improving compliance and stewardship. It also reviews the presence of grievance mechanisms, benefit-sharing arrangements, and transparency practices, all of which are critical for building legitimacy and trust. Finally, it checks for evidence of behavioural change, such as improved compliance, reduced destructive fishing, or adoption of sustainable practices.

Annex Table 6-7 Stakeholder participation: data sources, metadata, and assessment method

Category	Details
Data Sources	• NGO programs (FFI, MCC, WEA, WCS; IUCN) • Co-management agreements and CPA/CFi by-laws • SMART/Kobo monitoring datasets • Public awareness programs (MoE, UN-PAGE) • PCCMD/FiA/MoE stakeholder participation records
Metadata	• Number and diversity of stakeholders engaged • Inclusion of women, youth, Indigenous and marginalized groups • Geographic coverage and resourcing of co-management units • Existence of grievance-handling and benefit-sharing systems
Assessment Method	• Evaluate effectiveness and meaningfulness of stakeholder engagement.

	• Assess dependence on project-based participation versus institutionalised processes. • Identify evidence of behavioural change from outreach/co-management. • Identify gaps in grievance handling, benefit-sharing, and transparency.

Civil society organisations and co-management groups play a critical bridging role in monitoring, patrol support, and community engagement, yet participation remains project-dependent and uneven across provinces. While women and youth engagement is improving, gaps persist in grievance handling, transparent benefit-sharing, and long-term resourcing for CFis/CPAs and MFMA committees.

E Governance Performance and Effectiveness

This annex evaluates governance effectiveness using outcome-based indicators under the Transboundary Waters Assessment Framework (TWAF) and regional commitments such as SDS-SEA and RAP-MALI. It brings together ecological, social, and institutional metrics to assess whether governance systems are achieving meaningful results across five outcome domains: **stakeholder engagement, stress reduction, ecosystem state, social justice, and human well-being**.

Ecological indicators include CPUE trends, species composition, habitat restoration metrics, and MPA/MFMA METT scores. Pollution indicators (MoE/MPWT) and wastewater compliance levels help determine whether stressors are decreasing in high-risk coastal areas. Social outcomes incorporate poverty, livelihoods, access rights, and benefit-sharing.

The annex also integrates hazard and oil-spill readiness assessments (IMO/ITOPF) to determine governance capacity for risk reduction and emergency response. A critical dimension is the extent to which monitoring systems are **translated into adaptive decisions**, regulatory adjustments, or enforcement actions—rather than remaining purely descriptive.

The final analysis identifies systemic constraints that limit governance effectiveness, including underfunding, weak integration between land and sea planning, incomplete MSP frameworks, fragmented monitoring systems, and limited cross-agency coordination. These findings directly inform recommendations for improving Cambodia's coastal governance architecture.

Annex Table 6-8 Governance performance and effectiveness: data sources, metadata, and assessment method

Category	Details
Data Sources	• SDG 6.5.1 and 6.5.2 indicators • FiA marine catch monitoring (CPUE, effort, species, value) • METT/SMART evaluations of MPA/MFMA sites • MoE/MPWT pollution & wastewater monitoring • Poverty and well-being indicators • Oil-spill readiness (IMO/ITOPF)
Metadata	• Stress-reduction indicators (compliance, plastics reduction) • Ecosystem-state proxies (CPUE, habitat condition, MPA coverage)

	• Social-justice outcomes (access rights, livelihoods, benefit-sharing) • Risk indicators (hazard exposure & response capacity)
Assessment Method	• Apply TWGAF outcomes: engagement, stress reduction, ecosystem state, social justice, well-being. • Compare national progress against SDS-SEA and RAP-MALI commitments. • Assess translation of monitoring data into adaptive decisions. • Identify systemic bottlenecks (financing, integration, MSP gaps).

Governance performance shows pockets of progress—improving METT scores, stronger community engagement, and some local stress-reduction outcomes—but system-wide effectiveness is hampered by weak monitoring–decision linkages, limited financing, and incomplete MSP and pollution-control frameworks. Risk preparedness, especially for oil spills and climate hazards, remains insufficient relative to increasing development pressure and hazard exposure.

Annex Table 6-9 Institutions and duties/functions related to coastal–marine governance & qualitative observations

Institute	Mandate	Linkages to Marine Governance	Legal Foundation	Qualitative Observations
Ministry of Land Management, Urban Planning and Construction (MLMUPC)	Land policy, land-use planning, construction permitting, and resolution of land disputes including coastal areas; chairs NCCMD.	Integrates and oversees coastal land-use and development planning, including zoning for tourism, SEZs, and port expansion.	*Land Law (2001)*; *Construction Law (2019)*; *Royal Decree on NCCMD (2012)*.	Strong lateral coordination with MoE, FiA, and MPWT; critical role in preventing coastal land-use conflicts; capacity improving but enforcement inconsistent, especially regarding coastal EIAs and speculative land conversion.
Ministry of Environment (MoE)	Lead and manage environmental protection, biodiversity conservation, pollution control, and sustainable natural resource use.	Leads coastal/marine conservation, manages MPAs/MFMAs (delegated), chairs DCZMC for ICZM, oversees coastal water quality monitoring.	*Environment Code (2023)*; *Protected Areas Law (2008)*; *Sub-Decree on EIA (1999)*; *Royal Decree on NCSD (2015)*.	National lead for conservation and pollution monitoring; increasingly active in MPA/MFMA co-management; vertical linkages strong but resources for enforcement still limited; water-quality data improving.

Ministry of Agriculture, Forestry and Fisheries (MAFF)	Manage and control natural-resource use across Cambodia.	FiA manages marine and freshwater fisheries; DFC leads marine conservation enforcement, species protection, and MFMA governance.	*Fisheries Law (2006)*; *MAFF Prakas on Fisheries Management Areas*; *Sub-Decree on FiA Structure*.	Core authority for marine fisheries; strong patrol presence in some provinces; data systems improving (CPUE, SMART); livelihood programmes expanding, but enforcement uneven due to limited patrol assets.
Ministry of Mines and Energy (MME)	Promote industrial development, hydropower, mining, and oil/gas exploration.	Oversees offshore petroleum blocks; regulates coastal energy infrastructure with implications for marine habitats and oil-spill risks.	*Law on Petroleum (2019)*; *Mining Law (2001)*; MME regulatory prakas.	Engagement mainly linked to offshore blocks and hydropower; limited direct role in habitat governance; environmental safeguards improving but oil-spill readiness weak.
Ministry of Tourism (MoT)	Develop and regulate national tourism policies, tourism products, and services.	Oversees coastal tourism planning, infrastructure standards, and environmental quality for coastal destinations.	*Tourism Law (2009)*; national coastal tourism master plans.	Coastal tourism growth increases pressure; works well with MoE on beach clean-ups and water-quality monitoring; lacks long-term ecosystem-based tourism planning.
Ministry of Public Works and Transport (MPWT)	Responsible for national transport systems including ports, waterways, and maritime navigation.	Merchant Marine Department and GD Waterway–Maritime Transport regulate ports, vessel safety, wastewater from ships, and marine transport pollution.	*Law on Waterway Transport*; MPWT port regulations; maritime safety prakas.	Key for port wastewater, maritime regulations, and stormwater; compliance actions improving; monitoring capacity still low for ship-based pollution and port effluents.

National Committee on Coastal Area Management and Development (NCCMD)	Inter-ministerial coordination body for coastal development and management.	Leads integrated coastal management; coordinates ministries, approves coastal zoning, and supports ecosystem conservation and livelihoods.	*Royal Decree on NCCMD (2012)*.	Effective inter-ministerial coordination mechanism; provides vertical integration through PCCMDs; policy cycle partially complete; monitoring and enforcement depend on member ministries.
National Council for Sustainable Development (NCSD)	National body for climate change, green growth, environmental policy integration.	Leads national climate policy, supports marine climate adaptation, integrates biodiversity and SDG reporting.	*Royal Decree on NCSD (2015)*.	Strong climate leadership; integrates SDG and environmental policies; good cross-sector coordination; high-level but limited operational enforcement capacity.
Provincial/District Authorities (MoI)	Oversee local administration, development planning, and law enforcement.	Implement coastal regulations, enforce fishing rules, manage coastal land concessions, and coordinate local development.	*Law on Administrative Management of Capital, Provinces, Municipalities (2008)*.	Strong on-ground enforcement role; vertical coordination improving; gaps in technical expertise and budget; community engagement strong but enforcement varies widely by province.
Provincial Committee for Coastal Management and Development (PCCMD)	Provincial-level coastal planning and enforcement committee.	Coordinates marine patrols, coastal zoning, pollution control, and enforcement between MoE–FiA–police–military at provincial level.	*NCCMD Implementation Guidelines*; provincial prakas (Kep, Kampot, P. Sihanouk, Koh Kong).	Effective provincial coordination mechanism; strong in multi-agency patrols and rapid response; limited analytical capacity and budget for coastal planning; reliant on national-level guidance.

Annex 6-2 Explanatory Note: International Environmental and Governance Benchmarks: Cambodia

This annex provides additional detail on Cambodia's performance against selected **international environmental and governance benchmarks**, namely the **Environmental Performance Index (EPI)** and the **World Bank Worldwide Governance Indicators (WGI)**. These indicators are not used as direct performance measures within the TDA, but rather as **contextual benchmarks** to help interpret national governance capacity, systemic risks and constraints relevant to coastal and marine resource management.

A. Environmental Performance Index (EPI)

Cambodia's results in the **2024 Environmental Performance Index (EPI)** highlight the scale and persistence of its environmental management challenges. The country ranks **around 170th out of 180 countries**, with a composite score of approximately **31**, placing it in the **lowest global decile**. Over the past decade, Cambodia's overall EPI score has shown only **marginal improvement (Δ≈0.4)**, indicating limited progress in addressing structural environmental pressures.

From a coastal and marine governance perspective, several EPI components are particularly relevant:

Air quality and pollution

- **Air Quality:** Cambodia is ranked **158th** globally with a low score of **18.1**. Indicators like **Anthropogenic PM2.5 exposure** (rank 133) reflect the serious impact of air pollution on human health.
- **Air Pollution (Ecosystem Vitality):** Ranked **176th** with a score of **14.5**, this indicates very poor control over emissions affecting ecosystems, such as **nitrous oxides** and **sulfur dioxide** emissions growth rates (ranked 176 and 174, respectively).
- These pressures are closely linked to coastal urbanisation, port activity and tourism growth, with indirect effects on coastal and marine ecosystems through atmospheric deposition and urban runoff.

Climate Change and Ecosystem Vitality

Despite some areas of strength in biodiversity protection, performance in overall ecosystem health and climate mitigation is poor

- **Climate Change Mitigation:** Ranked **178th** globally with a score of **16.7**. This highlights the country's struggle to manage its **Greenhouse Gas (GHG) emissions growth rate**, especially for **carbon dioxide** (ranked 178).
- **Forests:** Ranked **110th** with a score of **37.6**. Cambodia is grappling with issues like **Primary Forest Loss** and **Tree cover loss**, largely attributed to illegal logging, agricultural expansion, and land conversion, which contributes to land degradation and deforestation.
- **Water Resources:** Ranked **150th** with a score of **13.4**. This low score reflects a major issue with inadequate infrastructure, particularly in **wastewater collection**

(rank 141) and **wastewater treated** (rank 148), which contributes to water pollution in inland and coastal areas.

- Cambodia ranks among the lowest globally for greenhouse-gas emissions trajectories, with rapid growth in CO_2 and other GHG emissions. While Cambodia's absolute emissions remain low in global terms, the trend reflects increasing reliance on fossil fuels, urban expansion and industrial activity, which compound climate risks affecting coastal zones (e.g. sea-level rise, heat stress and extreme events).

Areas of Relative Strength

While the overall rank is low, Cambodia shows better performance in specific indicators within the Ecosystem Vitality objective:

- **Biodiversity & Habitat:** Ranked **57th** with a score of **56.9**. The country scores relatively well in protecting specific areas, such as **Terrestrial Biome Protection** (rank 1, score 100.0) and **Species Protection Index** (rank 14), suggesting that a large portion of its terrestrial biomes is formally protected.
- **Agriculture:** Ranked **48th** with a score of **64.6**, notably high in **Phosphorus Surplus** management (rank 1, score 100.0) and **Relative Crop Yield** (rank 45).
- **Forest and land-use change:** EPI scores in this domain are moderate, but continued primary forest and tree-cover loss associated with agricultural expansion, economic land concessions and infrastructure development remain evident. These land-use changes increase sediment loads and alter freshwater inflows to estuaries, mangroves and nearshore habitats, with downstream implications for fisheries productivity and coastal ecosystem health.

Annex Table 6-10 Cambodia's EPI 2024 summary

Metric	Value	Interpretation
Global Rank	**170** (out of 180 countries)	Places Cambodia in the bottom 10% globally, indicating very poor environmental performance.
EPI Score	**31.2**	This low score suggests that the country is far from meeting established environmental policy targets across various issues.
Regional Rank	**22** (e.g., in the Asia-Pacific region)	Indicates poor performance relative to its regional peers.
10-Year Change (Δ)	**0.4**	Suggests a negligible improvement in environmental performance over the past decade.

Source: *Environmental Performance Index (EPI), 2024. Cambodia Country Profile*

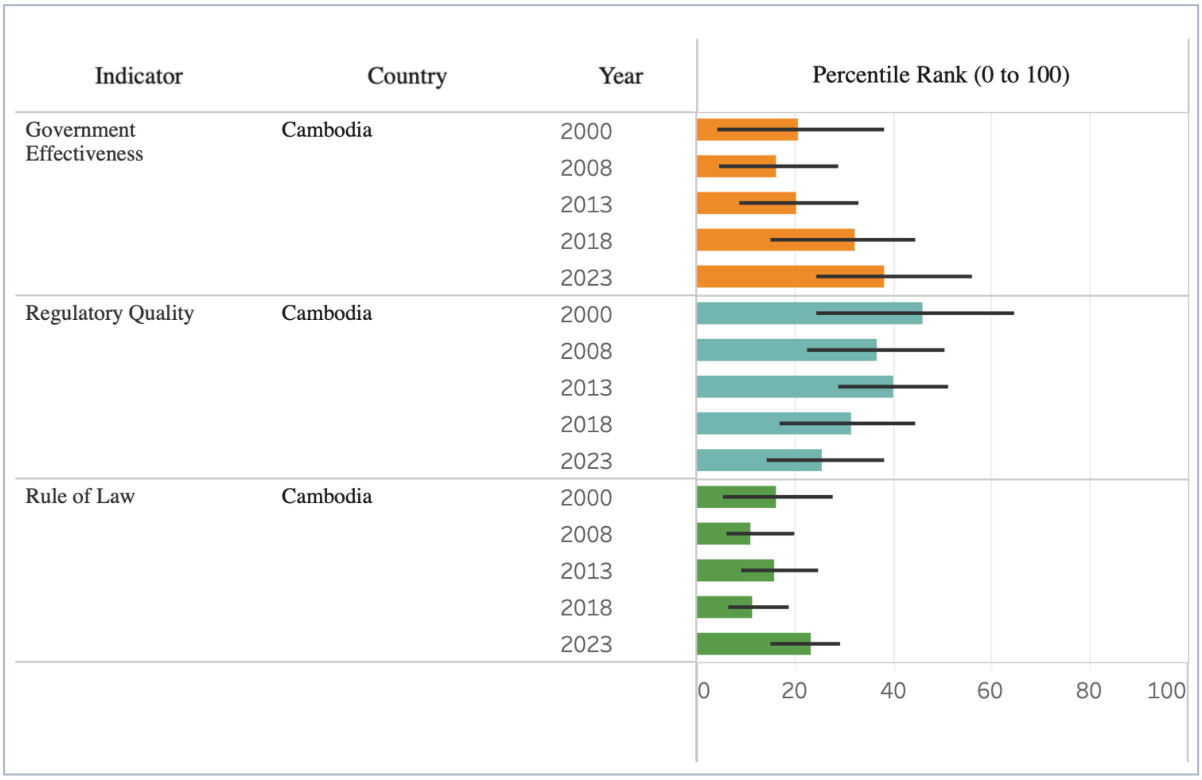
Areas of relative strength in the EPI include **biodiversity and habitat protection**, where terrestrial biome protection and species-related indicators score comparatively higher, and certain **agricultural indicators** (e.g. phosphorus surplus and relative crop yield). These results suggest that conservation designations and specific sectoral measures can be effective where implementation and enforcement are sustained.

Overall, for the purposes of this TDA, the EPI underscores that **structural pollution pressures, land-use change and climate-related risks remain high**, reinforcing the need for sustained investment in wastewater and solid-waste management, air-emissions control, and land-use planning that safeguards coastal ecosystems.

B. World Bank Worldwide Governance Indicators (WGI)

The **World Bank Worldwide Governance Indicators (WGI)** provide complementary insight into Cambodia's broader governance environment and its implications for coastal and marine management capacity. Cambodia's scores remain low across several dimensions that are directly relevant to environmental governance.

- **Government Effectiveness:** Cambodia ranks in approximately the **10–13th percentile globally**, reflecting weak perceptions of public-service quality, policy implementation and bureaucratic capacity. These constraints affect the ability of national and provincial administrations to plan, implement and sustain complex governance instruments such as **integrated coastal zone management (ICZM)**, **marine spatial planning (MSP)**, routine compliance monitoring and environmental service delivery.
- **Regulatory Quality:** With scores in the **15–20th percentile**, Cambodia faces challenges in designing and enforcing predictable, transparent and pro-environment regulatory frameworks. In coastal areas, this is reflected in uneven application of **EIA/SEA conditions**, limited cumulative-impact control, and difficulties in regulating ports, tourism development, fisheries, aquaculture and pollution sources in a coordinated manner.
- **Control of Corruption:** Cambodia's position in the **5–10th percentile globally** indicates persistent corruption risks in both public and private sectors. These risks undermine equitable benefit-sharing, increase the likelihood of non-compliant or informal development in sensitive coastal zones, and weaken trust in licensing, enforcement and grievance-redress mechanisms.



Annex Figure 6- 1 World Bank Worldwide Governance Indicators (WGI) – Cambodia

Source: *World Bank, 2024, Worldwide Governance Indicators, 2024 Update, World Bank.*

Annex 6-3 Explanatory Note: Rationale for Cambodia's TWAP Governance Scores

This annex records the basis for Cambodia's self-assigned scores under the **TWAP Governance Architecture Assessment Framework** (Fanning et al., 2017). Consistent with TWAP practice, the scoring is an **evidence-based qualitative judgment** drawing on the institutional review, indicators and risk discussion presented in Chapter 6. The framework assesses three attributes of governance architecture—**Completeness, Integration and Engagement**—as proxies for the extent to which governance arrangements are capable of delivering coherent, adaptive and inclusive management of coastal and marine systems.

A. Completeness (55–60%; Medium–Low)

Score rationale. Cambodia's completeness score reflects that the principal building blocks of a coastal–marine governance system are in place, including: (i) a broad legal and policy framework for environment, fisheries and protected areas; (ii) designated national and subnational institutions with mandates relevant to coastal and marine management; and (iii) a growing set of management instruments, including co-management arrangements (e.g., MFMAs/CPAs), compliance/patrol mechanisms and emerging monitoring and reporting functions.

Key evidence supporting the score.

- **Policy and legal coverage is largely present** across the main management functions (planning, regulation, conservation/co-management, compliance) and aligns with national strategies on environment and climate.
- **Institutions exist at multiple levels** (national–provincial–local) to implement sectoral mandates and coordinate selected cross-sector actions.
- **Monitoring and management tools are expanding**, particularly through site-based co-management and protected area systems.

Why the score is not higher. The policy cycle is not yet consistently operational across provinces and sectors. Constraints include **variable implementation and enforcement capacity**, uneven resourcing for routine functions (monitoring, laboratories, patrols, wastewater oversight), and limited institutionalization of **adaptive management** (systematic use of monitoring results to revise rules, zoning, investment priorities and budgets). These limitations reduce the effectiveness of otherwise complete formal arrangements, supporting a Medium–Low score.

B. Integration (0.35–0.45; High–Medium Risk)

Score rationale. Integration is assessed as the main structural weakness. While Cambodia demonstrates progress in selected coordination mechanisms and regional cooperation, governance for the coastal–marine space remains **fragmented across institutions and sectors**, particularly for sea-use decisions and land–sea interactions.

Key evidence supporting the score.

- **Vertical integration has advanced in principle** through national-to-subnational arrangements and expanding coastal management initiatives, and Cambodia participates actively in **regional cooperation** platforms relevant to SCS–GoT.
- However, **horizontal integration remains limited** among core coastal drivers (ports/shipping, tourism, urban development, wastewater/solid waste, fisheries and aquaculture).
- **Marine spatial planning is not yet fully operational**, and mandates related to sea-space planning, licensing, compliance and monitoring remain distributed, creating coordination gaps at the land–sea interface.

Why the score remains in the High–Medium risk band. The current architecture does not consistently enable "whole-of-government" coastal planning or cumulative impact control, especially where blue-economy investments intersect with sensitive habitats and pollution pathways. Sectoral decision-making therefore tends to remain **siloed**, and integration is often project- or site-dependent rather than institutionalized.

C. Engagement (45–55%; Medium)

Score rationale. Cambodia's engagement score reflects meaningful stakeholder participation in parts of the system—especially through co-management—while recognizing that participation and accountability mechanisms are **uneven across sectors and development contexts**.

Key evidence supporting the score.

- **Co-management platforms** (e.g., MFMAs and protected-area community arrangements) provide structured participation and have strengthened local stewardship and compliance in several locations.
- **Formal participation provisions** exist through EIA/SEA-related processes and other consultation mechanisms.

Why the score is not higher. Engagement is less consistent in large-scale coastal development contexts (e.g., ports/SEZs, reclamation, tourism corridors), where decision-making can be predominantly top-down. Coverage and quality of participation, grievance handling, transparency, and systematic inclusion of women, youth and vulnerable groups are variable. These gaps support a Medium engagement score.

Summary interpretation

Overall, Cambodia's governance architecture is assessed as **moderately complete** in terms of formal structures, but **less mature in integration and consistent implementation** across sectors and provinces. Engagement is **moderate**, anchored by co-management strengths but constrained by uneven participation and accountability in major coastal development processes. These results help explain why cumulative pressures (pollution, habitat conversion, coastal development intensity and resource-use conflicts) remain difficult to manage without further institutionalization of cross-sector planning, sustainable financing and routine compliance capacity.