

POLICY BRIEF

Tackling Local Threats to Save Coral Reefs:

Evidence-Based Priorities for the Northern South China Sea

Xu, Li, Liu et al. (2026) *Impacts of local anthropogenic stressors outpace those of climate on coral reef collapse in the northern South China Sea* | *Nature Communications* | doi:10.1038/s41467-026-70760-1

40%

decline in live coral cover over
two decades

73%

variation explained by local
anthropogenic stressors

2–4×

potential recovery with
integrated management

Executive Summary

Coral reefs in the northern South China Sea — one of the world's most ecologically and economically vital marine regions — have lost approximately 40% of their live coral cover (LCC) over the past two decades, falling well below the global average of 30%. A landmark two-decade study spanning 102 monitoring sites across 22 reefs demonstrates conclusively that local anthropogenic stressors — overfishing, agricultural nutrient runoff, and rapid coastal urbanisation — collectively explain 73% of this decline, substantially outweighing the impact of climate-driven thermal stress. This finding has profound implications: unlike global warming, these local stressors are directly actionable by regional and national governments. Targeted, place-specific management could increase LCC two to four times under plausible climate scenarios, preventing catastrophic reef calcification collapse.

Context and Problem

Coral reefs provide food, coastal protection, and livelihoods for hundreds of millions of people globally, yet global coverage of reef-building coral has fallen by roughly half since the 1950s. Climate change dominates global conservation narratives, but this framing can obscure the decisive role of controllable, local pressures — particularly in rapidly urbanising regions such as the South China Sea coast.

The northern South China Sea — encompassing Hainan Island and the Xisha (Paracel) archipelago — represents an urbanised reef hotspot under intense development pressure. The study by Xu, Li, Liu et al. (2026) fills the knowledge gap with 20 years of systematic monitoring data, advanced modelling, and spatial simulation of management scenarios.

Key Findings

1. Severe and Accelerating Reef Decline

Mean live coral coverage across the three study subregions fell to just 19% — below the global average of 30%. Figure 1 shows 20-year trends in LCC, reef fish density, and macroalgae across all three subregions. All regions show dramatic LCC decline since 2000, with parallel collapse of reef fish populations and algal overgrowth particularly acute in Hainan East.

Coral community change across three Hainan subregions, 2000–2020

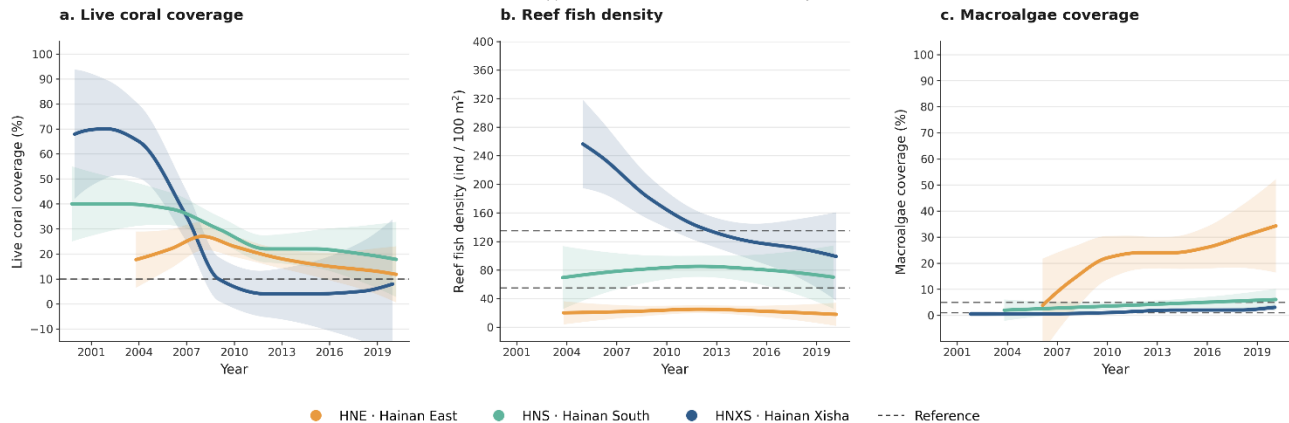
LOESS trend $\pm$ approximate 95% band across observed years

Figure 1. 20-year trends in (a) live coral coverage, (b) reef fish density, and (c) macroalgae coverage across Hainan East (HNE, orange), Hainan South (HNS, teal), and Hainan Xisha (HNXS, blue), 2000–2020.

2. Local Stressors Dominate — Not Climate

Panel regressions and structural equation models consistently identify overfishing as the single largest driver of LCC decline, with a 10% reduction in reef fish density associated with a 3.5–7.3% fall in LCC. Figure 3 presents the relative total effects for each subregion. Overfishing (Fish) is the dominant stressor in all three regions (28–45%), followed by macroalgae (14–25%), agricultural nitrogen (22–26%), population (10–19%), and turbidity (12%). Crown-of-Thorns Starfish (CoTS) outbreak is a major force in Hainan Xisha (21%), while sea surface temperature shows a smaller effect compared to the dominant anthropogenic and biological drivers.

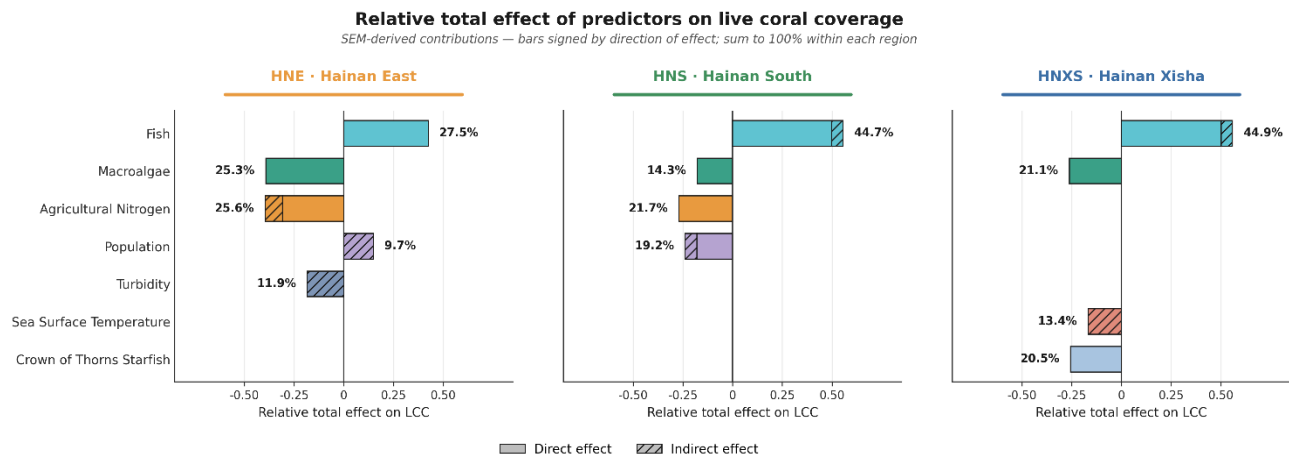


Figure 2. Relative total effects of stressors on live coral coverage (LCC) by subregion. Bars to the right of zero indicate positive effects; bars to the left indicate negative effects on LCC. Hatched fills denote indirect effects (through intermediate variables). Values represent percentage of total LCC variance explained.

Why Local Action Matters More Than Climate Action Alone

While marine heat waves have become more frequent since 2014 — and thermal bleaching risk is rising — the study finds that corals in the northern South China Sea retain historical resilience to thermal events rooted in millennia of adaptation. This means that reducing controllable local stressors now provides crucial buffer time while global emissions reductions take effect. Integrated local management could achieve a 2–4 times increase in coral cover even under continued global warming scenarios.

Policy Recommendations

The study proposes an Integrated Coast-Reef Management (ICRM) framework — shown in Figure 3 — that couples evaluation, stressor identification, tailored strategies, implementation, and monitoring across five governance tiers. Policymakers should prioritise the following actions:

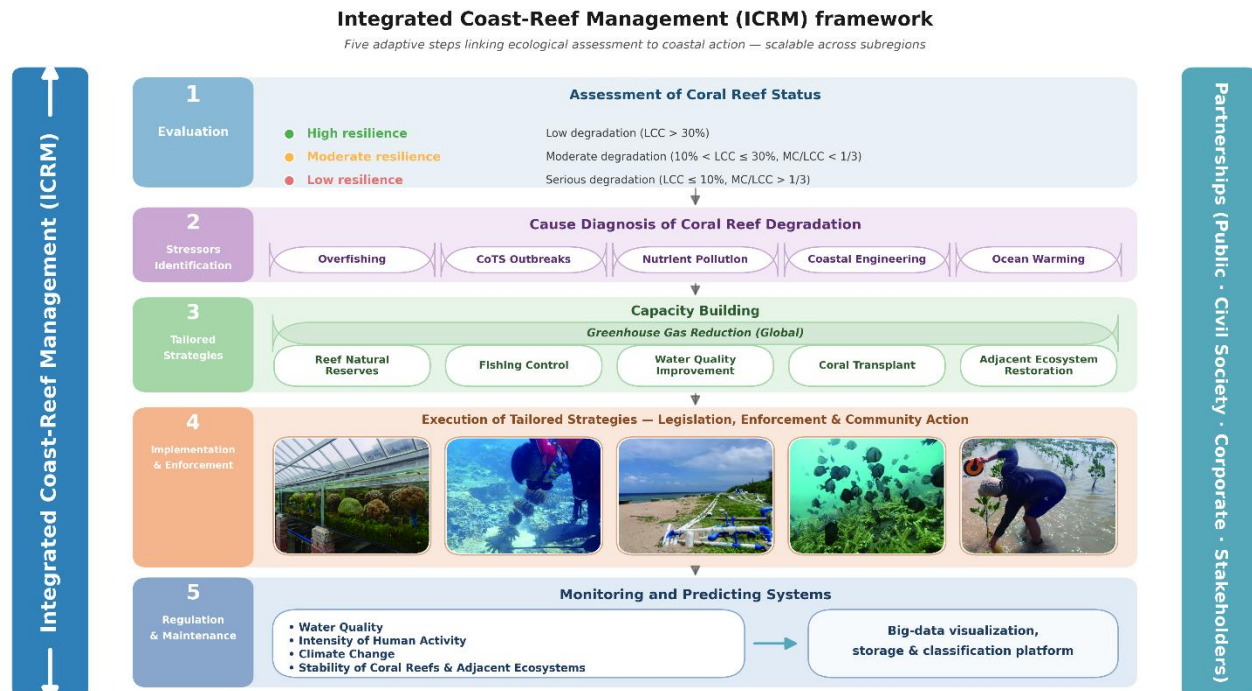


Figure 3. The Integrated Coast-Reef Management (ICRM) Framework. The framework moves from reef status evaluation through stressor identification to tailored intervention strategies, implementation, and regulatory monitoring, supported by multi-stakeholder partnerships and a big-data platform.

Priority 1: Overhaul Fisheries Management

- Strengthen fishing bans: existing summer bans have slowed but not reversed the decline.
- Eliminate destructive practices — blast fishing and cyanide fishing — through enforcement, alternative livelihood programmes, and community co-management.
- Restore keystone fish guilds: rehabilitation of both herbivorous and predatory fish is essential to re-establish trophic control.
- Set evidence-based minimum fish density targets (>250 ind/100m² required for autonomous reef recovery in some subregions).

Priority 2: Reduce Agricultural Nutrient Runoff

- Implement nutrient load caps on agricultural zones draining to reef-adjacent coastlines, using NUFER-type nutrient flow modelling to set scientific limits.
- Regulate mariculture effluent: prior to 2016, untreated mariculture discharge entered coastal waters; close remaining regulatory gaps.
- Incentivise precision agriculture to reduce nitrogen surplus at source.

Priority 3: Integrate Coastal Planning with Reef Protection

- Require reef health benchmarks in environmental impact assessment for coastal development.
- Fast-track wastewater treatment in high-growth coastal cities experiencing rapid migration.
- Establish buffer zones to restrict coastal construction within defined distances of living reefs.

Priority 4: Control Crown-of-Thorns Starfish (CoTS)

- Deploy systematic, coordinated CoTS removal programmes, especially in Hainan Xisha.
- Address underlying nutrient enrichment that triggers CoTS population explosions.

Priority 5: Build Monitoring and Governance Capacity

- Expand the monitoring network to an early-warning system feeding into a big-data visualisation and classification platform.
- Establish cross-sector governance structures — fisheries, agriculture, urban planning, environment — to coordinate ICRM implementation.
- Engage fishing communities, farmers, and tourism operators as partners in adaptive management.

Projected Outcomes Under Integrated Management

Spatial simulations show that integrated management with combined nutrient reduction and fisheries restoration could dramatically improve reef outcomes compared to current trajectories. These projections represent a 2–4 times improvement over current levels. Critically, they would prevent reefs from crossing the calcification collapse threshold — the point beyond which reefs can no longer sustain structural integrity and irreversible ecosystem loss begins.

+26%

Projected LCC — Hainan East
(vs. 12% baseline)

+31%

Projected LCC — Hainan South
(vs. 18% baseline)

+28%

Projected LCC — Hainan Xisha
(vs. 5% baseline)

Conclusion

The evidence from two decades of field monitoring is clear: coral reefs in the northern South China Sea are collapsing primarily because of locally driven, humanly controllable stressors. Climate change amplifies these pressures but is not the major cause of decline regionally. This is a message of both urgency and agency — governments, industries, and communities have the tools to act.

The Integrated Coast-Reef Management framework proposed by Xu, Li, Liu et al. (2026) provides a scientific and regionally calibrated roadmap. Adopting it — with commitment to fisheries management, nutrient reduction, and coastal planning — could see a faster recovery of coral cover, sustaining the biodiversity, fisheries, coastal protection, and tourism value that hundreds of millions of South China Sea communities depend upon.

Scalability Beyond the South China Sea

The authors note that their findings offer scalable solutions for other reef regions facing similar anthropogenic pressures — particularly rapidly urbanising tropical coastlines in Southeast Asia, East Africa, and the Pacific. The telecoupling analytical framework linking land-use change to reef condition through nutrient flow modelling can be adapted to other geographies, offering a replicable model for evidence-based reef governance worldwide.