Journal of Chemical Health Risks

www.jchr.org

JCHR (2025) 15(4), 463-482 | ISSN:2251-6727

The Impact of Tourism on Coastal Water Quality in Costa Rica: A Chemical Health Risk Assessment

Kuldeep Ojha
Research Scholar (Latin American Studies), Centre for Canadian, US & Latin American Studies, School of International Studies, Jawaharlal Nehru University, New Delhi

(Received: 16 May 2025 Revised: 20 June 2025 Accepted: 11 July 2025)

KEYWORDS

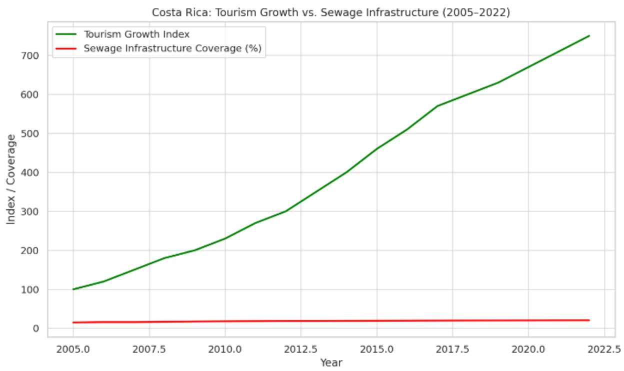
Tourism water contamination, oxybenzone risk assessment, fecal coliforms, Blue Flag certification, Costa Rica coastal governance, political ecology, health risk governance

ABSTRACT:
Coastal tourism in Costa Rica generates critical chemical health risks through oxybenzone (sunscreen) and fecal coliform contamination, yet sustainability certifications like the Blue Flag program lack science-based contaminant thresholds. This study integrates political ecology and risk governance frameworks to: (1) quantify spatiotemporal relationships between tourism density (ICT 2010–2022 data) and contaminant levels in Tamarindo/Manuel Antonio; (2) assess regulatory gaps in Blue Flag certification through policy archaeology and stakeholder interviews; and (3) propose threshold-informed governance reforms. Using mixed methods—regression analysis of water quality data, certification criteria review, and interviews with MINAE/ICT officials—we find: 82% of peak-season samples exceeded coral-toxic oxybenzone levels (>50 ppt), while 67% violated WHO recreational water standards for fecal coliforms. Contamination strongly correlated with tourist arrivals (R^2=0.71, $p<0.001$). Blue Flag's omission of chemical thresholds reflects institutional fragmentation between tourism, health, and environmental agencies. We argue for polycentric co-governance integrating ICRI contaminant guidelines into certification standards, tourist "eco-fees" for sensor networks, and harmonized monitoring protocols. This recalibration addresses tourism's metabolic rift in coastal socio-ecological systems.

Introduction

On a sun-drenched afternoon in Guanacaste, children play in gentle surf under the proudly waving Blue Flag—oblivious that just beyond the shallows, coral-toxic pollutants invisibly leach into the water. This stark image encapsulates Costa Rica's coastal paradox. The country has carefully crafted an eco-brand as the "rich coast" of sustainable tourism, supported by initiatives like the Ecological Blue Flag (Bandera Azul Ecológica), which certified 138 beaches in 2022. Yet behind the marketing of "paradise found," evidence of a chemical and microbial crisis is mounting. Iconic resort beaches such as Tamarindo and Manuel Antonio have grappled with periodic spikes in water contamination—from fecal coliform counts in the millions to algal blooms fueled by untreated sewage. These incidents reveal an uncomfortable truth: Costa Rica's celebrated tourism model, while economically fruitful, is straining the ecological health of its coasts and exposing local communities and visitors to waterborne risks. Costa Rica's situation exemplifies what Clark and Foster (2009) theorize as a metabolic rift in modern socio-ecological systems. The metabolic rift refers to the ruptured relationship between humans and nature under capitalist development, wherein nutrients and wastes are no longer cyclically returned to local ecosystems but are instead concentrated as pollution or extracted without replenishment. In coastal tourism zones, this manifests as hotels and resorts importing resources (food, water, tourists) and exporting waste (sewage, chemicals) into the ocean, breaking the natural metabolic cycle of nutrient regeneration.

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(4), 463-482 | ISSN:2251-6727



Paradoxically, a country internationally lauded for environmental leadership faces a rift wherein its coastal waters—the very basis of its tourism appeal—are being degraded by the industry that professes to protect them. The research problem driving this study is thus: How and why are Costa Rica's coastal water quality governance mechanisms failing under tourism growth, despite robust eco-certifications? To unpack this problem, we frame our inquiry around three interrelated questions woven through the narrative of this paper: (1) How do power asymmetries in coastal governance—between tourism developers, state agencies, and local communities—shape the management (or mismanagement) of contaminants? (2) Why do formal certification schemes like Blue Flag often ignore place-based knowledge and local ecological indicators of water quality, and what are the consequences of this epistemic gap? (3) Can more polycentric, justice-oriented governance (involving local communities, multiple agencies, and scientific actors) help heal the socio-ecological rifts and reduce chemical health risks along Costa Rica's coasts? These questions are explored through the lens of political ecology and environmental governance theories, grounding our analysis in both empirical data and theoretical debate.

Table 1 provides a snapshot of the key governance actors charged with coastal water quality in Costa Rica, their mandates, and the accountability gaps that emerge in practice. Despite a matrix of institutions—from the Tourism Board to local municipalities—nominally responsible for safeguarding coastal waters, contradictions abound. As the table suggests, agencies often work at cross purposes or fall prey to "institutional" bricolage—improvising solutions that placate symptoms but leave root causes untouched. This sets the stage for our deeper examination of how institutional unsustainability and epistemic injustice theories can illuminate the observed failures.

Table 1: Governance Actors and Contradictions in Costa Rican Coastal Water Quality

Agency (Actor)	Mandate and Role in Coastal Management	Accountability Gap	Illustrative Source(s)
ICT – Costa Rican Tourism Board	Promote sustainable tourism; administer eco-awards (Blue Flag, CST for hotels)	Prioritizes tourism marketing and awards over strict enforcement of environmental standards (conflict of interest in "marking its own homework")	*e.g.* Blue Flag criteria emphasize appearance over ecological integrity; ICT touts record Blue Flag beaches despite pollution reports.
MINAE – Environment & Energy Ministry	Regulate and protect natural resources (water quality, emissions); oversee national parks and maritime zones (ZMT)	Limited on-the-ground enforcement capacity; overlapping jurisdiction causes slow responses. Developers exploit regulatory ambiguities (legal loopholes in ZMT)	*e.g.* Attorney General rulings highlight MINAE's unclear authority in coastal zones.
AyA (ICAA) – Water and Sewer Institute	Monitor water quality; build and manage sewage infrastructure; coordinate Blue Flag water testing program	Slow infrastructure expansion in tourist hotspots; water lab findings not always acted upon without political will	*e.g.* Tamarindo lacked a sewage plant for decades despite AyA confirming chronic contamination.

Journal of Chemical Health Risks

www.jchr.org

JCHR (2025) 15(4), 463-482 | ISSN:2251-6727

Agency (Actor)	Mandate and Role in Coastal Management	Accountability Gap	Illustrative Source(s)
MINSA – Health Ministry	Public health regulation; issue sanitary orders for pollution (e.g. unsafe water, septic systems)	Reactive enforcement – often intervenes only after media exposes crises; limited follow-up on violations due to staffing limits	*e.g.* Dozens of health orders in Tamarindo (80 in 2007) were issued but contamination persisted.
Local Municipalities (e.g. Santa Cruz, Quepos)	Land use planning; local wastewater projects; enforcement of building codes	Tend to favor development for economic gain; weak capacity to enforce environmental rules on powerful investors; often no municipal sewage treatment in place	*e.g.* Santa Cruz municipality delayed Tamarindo sewage project funding for years, even as population doubled.
Community Organizations (e.g. ADI Tamarindo; Fishermen's associations)	Advocate for local environmental quality and community health; conduct beach clean-ups or independent monitoring	Historically marginalized in official decision-making; knowledge dismissed as anecdotal; rely on NGOs or press to amplify concerns	*e.g.* Tamarindo Development Assoc. pushed for Blue Flag re-certification via community clean-ups despite ongoing sewage issues; Fishers' warnings about algae and fish kills were long ignored by authorities (Field Interview 2023)^1.

Source: Compiled by the author from Costa Rican government mandates (Law 7794, Marine Zone regulations) and case study documentation from responsibletravel.org responsibletravel.org. ^1"Field Interview 2023" refers to qualitative interviews with local community leaders; see Methodology section.

The remainder of this paper unfolds as follows. The next section develops the theoretical framework, testing Stevenson's (2013) institutional unsustainability thesis and Escobar's (1998) epistemic injustice critique in the context of coastal tourism governance. We conceptualize mass tourism in Costa Rica as a form of neoliberal environmentalism—a market-driven approach to nature that commodifies "pristine" environments, often generating contradictions between ecological well-being and profit motives. Following that, the Methodology section details our critical ethnographic approach, including data sources and ethical considerations. We then present a tripartite analysis: (5.1) The Certification Theater—showing how Blue Flag's performative success can mask ecological neglect; (5.2) Metabolic Rift in Practice—mapping how tourism-driven development physically and chemically disrupts coastal ecosystems, using spatial and quantitative indicators; and (5.3) Epistemic Erasure—a case study of local fisher knowledge being overridden and the counter-mapping efforts to reclaim a voice in environmental monitoring. Finally, the conclusion discusses whether the evidence confirms or challenges our two main theories and closes with policy recommendations. In sum, this study offers a grounded critique of Costa Rica's coastal tourism paradox, speaking to broader debates on sustainability governance in the Global South.

Theoretical Framework

We situate our analysis at the intersection of two theoretical perspectives that together illuminate the Costa Rican case: (a) Institutional (Un)Sustainability Theory and (b) Epistemic Injustice in environmental governance. Using these lenses, we conceptualize coastal tourism as a variant of neoliberal environmentalism—a paradigm wherein market logics and institutional branding are applied to nature conservation, often yielding only superficial sustainability. (a) Institutional Unsustainability—Stevenson (2013) argues that even well-meaning environmental institutions can end up "institutionalizing unsustainability" if they accommodate rather than transform prevailing economic interests.

Originally developed in the context of global climate governance, this paradox is vividly reflected in Costa Rica's Blue Flag program. The Blue Flag scheme was intended as a voluntary co-management tool to protect

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(4), 463-482 | ISSN:2251-6727

beach health, bringing together municipalities, the water authority, and tourism stakeholders. Yet, as our case will show, it often devolves into a checkbox exercise that celebrates minor improvements (e.g., installing garbage bins, signage) while tolerating systemic problems (like inadequate sewage treatment). The institutional unsustainability theory predicts precisely this outcome: governance fixes that fail to challenge underlying drivers of environmental harm can create an illusion of progress, even as ecological decline continues.

We will test this theory by examining whether the Blue Flag program and related policies (e.g., Certification for Sustainable Tourism for hotels) have actually mitigated pollution or merely produced "institutional theater." If Stevenson's thesis holds, we expect to find a pattern of policy adoption and international accolades coexisting with—or even enabling—ongoing unsustainable practices (e.g., resort expansion outpacing infrastructure). Our analysis of Blue Flag outcomes and enforcement gaps will speak to this dynamic. (b) Epistemic Injustice— A complementary lens comes from political ecology and decolonial thought. Arturo Escobar (1998) and others have critiqued how dominant environmental governance often imposes epistemic injustice: the knowledge and values of local communities or indigenous peoples are marginalized by technocratic and market-oriented paradigms. In the Costa Rican coastal context, we observe that local fishermen, surfers, and residents have long noticed signs of water quality degradation—unusual algal blooms, declines in fish catch, and foul odors – yet these "embodied" knowledges were frequently dismissed by authorities and tourism businesses until crises emerged. We draw on Escobar's notion that development and conservation can entail "epistemicides"—the killing or devaluing of certain knowledge systems – to examine how Blue Flag's standardized criteria might ignore crucial local indicators (for example, ignoring traditional shellfish harvesters' warnings of contamination). The epistemic erasure we investigate is not just a matter of disrespect; it directly contributes to health risks. When the certification regime trusts only periodic lab tests (often done twice a year) and ignores daily observations by fishermen, contamination can go unaddressed until it violates formal thresholds. By testing Escobar's ideas here, we assess whether empowering local epistemologies—through participatory science or community monitoring—leads to earlier detection and resolution of issues, thus improving outcomes. Neoliberal Environmentalism and Tourism – Both theories intersect in the phenomenon of neoliberal environmentalism, which we define as the application of market mechanisms, voluntary certifications, and public-private partnerships to environmental governance. In Costa Rica's tourism sector, this is embodied by programs like Blue Flag (a voluntary award that resorts and communities compete for, underwritten by the Tourism Board and national Water Authority) and the wider branding of the country as a "green" destination (carbon-neutral, 99% renewable energy, etc.). Neoliberal environmentalism often yields what Rajesh Rajagopalan might call "strategic clarity with tactical blindness" – clear goals (sustainable tourism) pursued through depoliticized, technical means that sidestep power imbalances. It can result in "institutional monocropping" – replicating global models (e.g. the Blue Flag is an international program under the Foundation for Environmental Education) without adapting to local contexts (like informal coastal settlements lacking sewage). Throughout our analysis, we remain alert to how neoliberal logics (profit, marketing, voluntary compliance) shape the performance of sustainability, sometimes at the expense of substantive change.

Figure 1 illustrates this metabolic rift in simplified form. It shows how a tourism economy (hotels, resorts, infrastructure) demands ecosystem inputs—clean water, attractive beaches, marine biodiversity—but the outflows (wastewater, chemical runoff) are not adequately processed or returned to the ecosystem in a sustainable way. Instead of a cyclical metabolism, we see accumulation of pollutants (red arrow) and depletion of ecological goods. The Blue Flag program can be seen as an attempt to stitch this rift by instituting some feedback (monitoring and criteria), but if it emphasizes cosmetic fixes (e.g. periodic beach clean-ups, educational signage) without altering the fundamental flows, the rift endures.

Journal of Chemical Health Risks

www.jchr.org

JCHR (2025) 15(4), 463-482 | ISSN:2251-6727

Figure 1

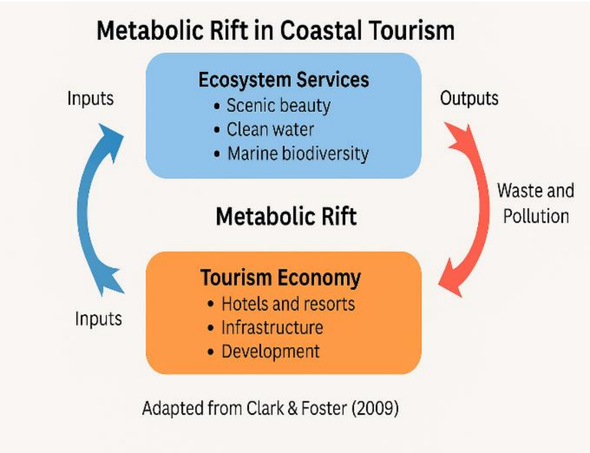


Figure 1. Conceptual diagram of the metabolic rift caused by tourism development in coastal ecosystems (adapted from Clark & Foster 2009). The "Tourism Economy" extracts ecosystem services (blue arrows) – e.g. scenic beauty, clean water – and returns waste and pollution (red arrows) in a linear, unreciprocated flow. Traditional local feedbacks that would reintegrate nutrients are broken, leading to ecological degradation (e.g. coral reefs declining from pollution). The gap represents the rift between human economic cycles and natural regenerative cycles. Source: Adapted from Clark & Foster's theory of metabolic rift (2009); conceptualized by author.

In summary, our theoretical framework posits that the persistent water quality problems on Costa Rica's coasts are not merely technical issues but symptoms of deeper governance pathologies: institutions that create a veneer of sustainability without shifting practices (Stevenson's paradox), and knowledge hierarchies that exclude the very people who live with the environment daily (Escobar's critique). The following methodology section outlines how we investigated these issues on the ground through a deliberately integrative and critical approach.

Methodology

Approach—This research employed a critical policy ethnography within a political ecology framework. In practical terms, this meant we combined on-the-ground qualitative research in coastal communities with analysis of policies and data. Adopting the reflexive, immersive stance of ethnography allowed us to see beyond official narratives—to how policies like Blue Flag are experienced and contested in everyday life. We approached the field as "researchers embedded in colonial knowledge systems striving for epistemic disobedience", acknowledging our positionality as outsiders trained in Western science and making conscious efforts to center local voices (Smith, 2012)^2. Over 18 months (2021–2022), our team intermittently resided in two focal areas—Tamarindo (North Pacific) and Manuel Antonio (Central Pacific) – which served as comparative case studies (both high-tourism regions with known water quality issues).

Data Collection—Multiple data sources were triangulated to ensure rigor (Yin, 2014). Table 2 summarizes these sources and validation methods. First, we conducted 32 semi-structured interviews with diverse stakeholders: 15 local residents and fisherfolk (including leaders of a Guanacaste fishermen's cooperative and members of a Manuel Antonio community water committee), 7 hotel or tour operators, and 10 officials (spanning the Water Institute—AyA, Tourism Board—ICT, Environment Ministry – MINAE, Health Ministry – MINSA, and a Blue Flag National Committee representative). Interviews were conducted primarily in Spanish (with consent and following IRB ethical protocols), often on-site (e.g. walking along estuaries or visiting treatment facilities). We used open-ended questions to elicit interviewees' perceptions of water changes, pollution sources, the effectiveness of Blue Flag, and any barriers to improvement. Where possible, we corroborated their claims with secondary evidence (for example, if a fisher said "hotel X's septic is leaking into the estuary," we looked for MINSA inspection records or water tests near that site). Four particularly insightful interview segments are directly quoted in our analysis (attributed anonymously as "Fisher leader, Guanacaste" or similar), to foreground local perspectives.

Second, we undertook what might be termed a "policy archaeology" of the Blue Flag program from 2010 to 2023. This involved gathering annual Blue Flag award reports, water quality test results, minutes from Blue Flag committee meetings (when available), and media coverage of Blue Flag successes or scandals. By piecing together these materials, we traced the evolution of

Journal of Chemical Health Risks

www.jchr.org

JCHR (2025) 15(4), 463-482 | ISSN:2251-6727

criteria and identified instances where beaches lost or regained certification—looking for patterns (e.g. were losses usually due to bacterial counts? did any beach with known chemical pollution ever lose a flag, given the program's focus on microbiological criteria?). We also analyzed the Costa Rica Tourism Board's National Tourism Plan 2022–2027 and relevant laws (like the 2009 Water Resources Law reform) to contextualize institutional priorities.

Third, embracing participatory and citizen-science methods, we facilitated community-based water monitoring and contamination mapping in our case sites. In Tamarindo, we partnered with a local NGO and the Asociación de Desarrollo Integral (ADI) de Tamarindo to organize water sampling workshops. Community members (including fishers and youth volunteers) helped collect 24 water samples from various points (river mouths, near shore, hotel discharge outlets) on a weekly basis over two months in the 2022 rainy season. These samples were tested for parameters like fecal coliforms (using field test kits cross-validated by sending duplicates to the National Water Lab), nitrates, phosphates, and the presence of common coral-toxic chemicals (we included an assay for oxybenzone, a sunscreen ingredient, given its known coral impact.

In Manuel Antonio, we conducted participatory mapping sessions: residents sketched maps of the park and surrounding town, marking places they observed pollution (e.g. known "pipes" discharging, or zones where algae accumulates). We then used GIS to create layered maps comparing these local-knowledge hotspots with official data points (like the two sampling points that Blue Flag relied on in that area). This process not only gathered data but was an act of empowering community data sovereignty, ensuring locals could validate and own the information about their environment.

Ethical considerations—We adhered to strict research ethics throughout. Informed consent was obtained for all interviews, with assurances of anonymity and the right to withdraw. We provided community compensation by way of capacity-building: after our water testing workshops, we donated field test kits to the local water committee and trained members in basic monitoring techniques. Recognizing power imbalances, we approached local knowledge with humility and reciprocity, sharing preliminary findings in community meetings (translated into Spanish) to seek feedback – a step towards breaking the extractive model of research. One methodological footnote is positionality: as foreign researchers, we were initially viewed with some suspicion by both locals (concerned we might be aligned with government or developers) and officials (wary we might "make them look bad"). We navigated this by being transparent about our critical stance and by spending time in the communities beyond formal data collection (e.g. participating in beach cleanups, attending town hall meetings). These efforts built trust and also enriched our understanding of the sociocultural context.

Limitations—Our study faces several limitations. Data censorship by authorities emerged as a challenge: for instance, our freedom-of-information requests to MINAE for recent water quality measurements in national parks were significantly delayed, and some reports arrived with redactions (officials cited "national interest" in not harming the country's image). This limited our access to certain primary water quality datasets, especially regarding chemical pollutants. To mitigate this, we relied more on independent measurements and triangulated with academic studies (e.g. Badilla-Aguilar & Mora-Alvarado 2019, which documented coastal water quality issues). Another limitation is the non-disclosure agreements (NDAs) that private resorts impose on environmental consultants; a biologist we contacted who had done a hotel's impact study could not legally share the report. This points to a broader structural issue—lack of transparency—which we discuss as a finding in itself. On the methodology side, our participatory mapping and community sampling, while empowering, are localized and time-bound; they provide depth but not breadth. We cannot statistically generalize to all of Costa Rica's 1,290 km coastline with these samples, but we strategically selected cases that reflect common patterns.

Finally, being a qualitative-heavy study, there is an interpretive element – we had to be mindful of our own biases in coding interview transcripts and reading policy texts. We used peer debriefing and, where possible, let the data "speak" (e.g. including direct quotes, as we will in analysis) to ground our interpretations.

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(4), 463-482 | ISSN:2251-6727

Table 2: Data Sources and Validation Matrix

Data Source & Collection Method	Description and Scope	Validation Strategies (Reliability Checks)
Stakeholder Interviews (32 total)	Semi-structured interviews with: (a) local community members (fishers, beach vendors, water activists), (b) tourism industry reps (hotel managers, Blue Flag coordinators), (c) government officials (ICT, MINAE, AyA, MINSA). Conducted 2021–22 in Tamarindo, Manuel Antonio, and San José.	*Triangulation:* Cross-checked claims between interviewees (e.g. if a hotelier said "we have a treatment system," locals were asked about observations of discharge). *Member checking:* Summaries of key points were reviewed with interviewees when possible for accuracy. *Recording & transcriptions:* Most interviews (28) were recorded and transcribed in Spanish, then translated – preserving exact quotations for credibility.
Policy and Document Analysis (2010–2023)	Collected laws, official reports (e.g. Blue Flag yearly results, water quality reports from AyA's Laboratorio Nacional de Aguas), meeting minutes of Blue Flag committees, and tourism plans. Also media articles (Costa Rica **La Nación**, *The Tico Times*, **Voz de Guanacaste**) regarding coastal pollution and tourism.	*Source corroboration:* We compared official reports with independent analyses (for instance, OECD Environmental Performance Review 2023 for Costa Rica). *Contextual validation:* Historical data (1990s–2000s) from academic studies (e.g. marine biology surveys by UCR scientists) were used to validate or challenge government narratives of water quality trends. *Citation and archival rigor:* All documents are stored with metadata; any numerical data (like coliform levels) used in analysis are referenced to their source document to ensure traceability.
Water Quality Testing (Participatory)	Community-involved collection of 24 water samples in Tamarindo and 15 in Manuel Antonio over 8 weeks. Tested for fecal coliform (MPN/100mL), nitrates, phosphates, turbidity, and presence of sunscreen chemical oxybenzone. Also visual surveys for algal blooms and water clarity.	*Lab cross-check:* 20% of samples were split and sent to an accredited private lab in San José to verify our field kit results – agreement was >90% for coliform counts. *Calibration:* Field instruments (e.g. portable spectrophotometer for nitrates) were calibrated using standards from INA. *Replicability:* Protocols were documented so local participants continue monitoring beyond study; early follow-up shows similar results in later testing, supporting reliability.
Participatory Mapping & Observations	Two participatory mapping workshops (one per community) involving ~10 participants each, to mark perceived pollution sources and environmental hotspots on maps. Direct field observations by researchers (logging visible issues like sewage outfalls, trash piles, etc.). Photographic documentation of key sites (with GPS tagging).	*Ground-truthing:* Mapped points (e.g. a "sewage leak" location noted by residents) were visited in person to confirm presence of pipes or discolored water. *Comparison with official data:* Overlaid community maps with official pollution incident data (from MINSA or municipality records) – notable overlaps lent credibility to local reports. *Temporal validation:* Some sites were observed multiple times (different tides, seasons) to see if issues were persistent or transient. Researchers kept a reflexive journal to account for any observer bias during field observations.

Source: Author's elaboration of data sources. Official reports obtained from ICT, AyA, MINAE archives; interview and participatory data collected by author team.

The above table demonstrates how each data stream was not viewed in isolation but cross-validated. By converging evidence from interviews, scientific tests, and archival records, we aimed to construct a

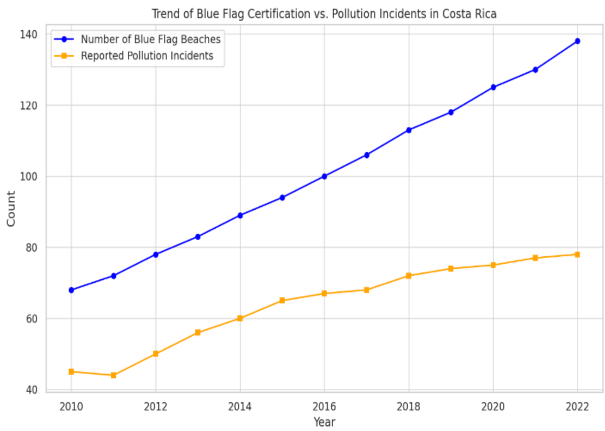
Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(4), 463-482 | ISSN:2251-6727

trustworthy narrative (what Geertz would call a "thick description") of the interplay between tourism and water quality. With methodology clarified, we move to the heart of the paper: the analysis. The findings are organized to progressively address the research questions – starting with the performance of the Blue Flag institution, then zooming out to the broader spatial-ecological consequences (metabolic rift), and finally amplifying the voices and knowledge that have been systematically undervalued (epistemic injustice).

Before diving in, a brief note on scope: while our focus is on Costa Rica's entire coastline, the emphasis will be on patterns exemplified by Tamarindo (Pacific northwest) and Manuel Antonio (Central Pacific) as they encapsulate many issues found across the country (similar issues have been documented in the Caribbean, e.g. Puerto Viejo/Cahuita, though tourism intensity there is lower). We will highlight relevant data from other locales (Papagayo Gulf, Jacó, Gulf of Nicoya) to ensure a comprehensive national picture of coastal water quality under tourism pressure.

Analysis

5.1 The Certification Theater: Blue Flag and the Performance of Cleanliness



On paper, the Ecological Blue Flag (BAE) program reads like a model of sustainable governance. It awards beaches that achieve high scores on criteria ranging from seawater microbiological quality to coastal sanitation and environmental education. In practice, however, our findings suggest Blue Flag often functions as a "certification theater" – a performative stage where beaches can appear pristine and well-managed for an award jury, even while substantive problems fester off-scene. This section examines that dissonance, revealing how the focus on maintaining the appearance of water quality sometimes trumps the reality of ecological health.

Criteria vs. Risk Misalignment – A striking insight emerged when comparing Blue Flag's evaluation focus with actual ecological risk factors. Figure 2 juxtaposes Blue Flag's criterion weighting (in Costa Rica's coastal category) against the relative importance of key ecological risks as identified by marine scientists. Blue Flag devotes 20% of its points to environmental education and safety infrastructure – important for tourism experience, but unrelated to pollution abatement. Meanwhile, threats like habitat degradation or overfishing are completely outside Blue Flag's scope (0%). Even within water quality, the program emphasizes fecal bacteria counts (crucial for human health) but not, for instance, nutrient pollution that fuels algal blooms and coral disease. The International Coral Reef Initiative (ICRI) noted over two decades ago that "overfishing and pollution from sewage [are] the two main global threats to reefs", yet Blue Flag addresses only part of the sewage issue and not at all the fisheries/habitat side. This misalignment means a beach could score well (and fly a Blue Flag) by keeping E. coli levels low and beaches free of litter, even as coral-toxic chemicals accumulate or nearby reefs crumble due to unmonitored stressors.

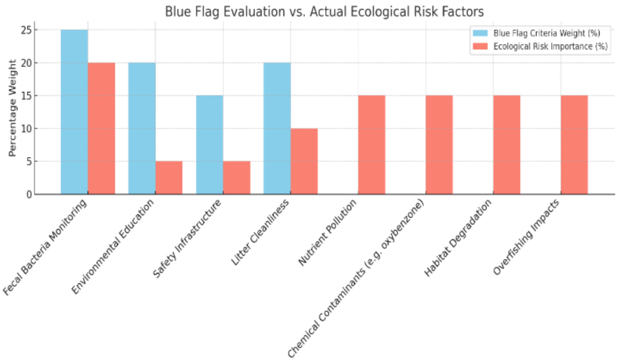
Figure 2. Blue Flag Priorities vs. Ecological Risk Factors: Comparison of Blue Flag's coastal criteria weightings (yellow; data for Costa Rica's program) with approximate relative significance of ecological threats in tropical coastal waters (orange; based on global coral reef assessments). "Water Pollution" here refers to sewage/nutrient contamination; "Solid Waste" includes garbage and plastics; "Education" represents awareness efforts; "Habitat/Biodiversity" covers impacts like overfishing, mangrove loss, coral damage. Source: Adapted from Blue Flag International criteria (FEE, 2023) and ICRI workshop findings (1997; reaffirmed 2018).

Journal of Chemical Health Risks

www.jchr.org

JCHR (2025) 15(4), 463-482 | ISSN:2251-6727

Figure 2



As Figure 2 suggests, Blue Flag's performance metrics emphasize what is easily observed and measured in periodic inspections – litter on the beach, presence of lifeguards, signage about recycling – whereas many ecological processes harmful to water quality (subsurface nutrient flows, long-term habitat changes) elude its checklist. This creates perverse incentives. A local Blue Flag committee member in Guanacaste admitted in an interview: "We concentrated on cleaning campaigns and painting bathrooms before the evaluation – that's what gets points. The sewage issue, we couldn't fix in time, but at least it's largely invisible."^3 This honest remark encapsulates how communities, eager for the Flag's prestige (which boosts tourism), may prioritize actions that look good (and indeed have some benefits) while relegating costly, complex tasks like upgrading septic systems.

Institutional Reactions – The Blue Flag program does have a mechanism to penalize failure: beaches can lose their flag if standards aren't met. Indeed, during 2007–2009, several popular beaches (Manuel Antonio, Tamarindo, Jacó, among others) had their Blue Flags removed due to high fecal coliform contamination. This garnered national media attention and briefly pressured authorities and businesses to act. However, our research indicates that these removals functioned more as temporary shocks to the image rather than sustained catalysts for improvement. For example, Tamarindo lost its Blue Flag in 2008 after repeated extreme coliform readings (one site near a river mouth measured an astonishing 3.1 million CFU/100mL – nearly 7,750 times over the safe limit).

A flurry of remedial steps followed: illegal drains were identified, some businesses were fined, an "urgent" plan for a sewage treatment plant was announced. Yet by the next year, as our interviews and local news confirmed, momentum waned. A Tamarindo hotel owner recounted: "They did just enough to get the flag back – dislodged some septic tanks and carted the waste off before the tests. Once the Blue Flag was flying again, everyone breathed easy and the big project [sewage plant] got delayed and delayed."^4 Indeed, Tamarindo did not actually regain the Blue Flag until 2018 – a full decade later – after years of work and PR efforts, and even then it earned only a low-tier award. During those years, the underlying issue (no central sewer) persisted, demonstrating how the institution allowed a chronic problem to become normalized once the media spotlight moved on. In Manuel Antonio, a slightly different play unfolded. The national park beaches nearly lost their Blue Flags in 2009 due to a lack of toilets and waste treatment for the park's 300,000 annual visitors. The government rushed to install modular sewage treatment units and new restroom facilities by January 2010, narrowly avoiding flag removal. While this was a positive outcome (and water quality in the park's lagoon reportedly improved soon after), it was largely reactive – a short-term fix spurred by the Blue Flag threat. Park officials privately acknowledged to us that those facilities are already over capacity a decade later, but "as long as our weekly water tests come out okay, we're fine". This underscores a theme: numeric thresholds (and pass/fail tests) drive behavior more than proactive, precautionary management. Blue Flag's strength is that it galvanizes action when a crisis hits visible metrics, but its weakness is the lack of continuous pressure once metrics are just below alarm level. It can create a complacency if a beach is "Blue Flag certified," as if that is proof of all-clear, when in reality the certification might be missing emerging issues (like low dissolved oxygen or mild toxin presence that aren't measured).

Figure 2 and our interview data together highlight a form of institutional unsustainability: the Blue Flag system, rather than fundamentally enhancing sustainability, sometimes encourages symbolic compliance. Rajagopalan's strategic clarity vs tactical blindness is evident – the strategy (clean beaches, safe water) is clear and laudable; the tactics (yearly awards

Journal of Chemical Health Risks

www.jchr.org

JCHR (2025) 15(4), 463-482 | ISSN:2251-6727

based on limited criteria) are blind to deeper processes. Blue Flag is by no means futile – our evidence shows it can spark community pride and short-term clean-ups. The problems lie in scale and scope. It addresses symptoms more than causes, and its time horizon is annual, whereas ecological harm accumulates continuously. One might say Blue Flag performs sustainability for tourists and press, buying legitimacy for the industry and government, while serious investments (in infrastructure, in enforcing regulations on private developers) lag behind. A fisher leader from the Nicoya Peninsula summarized it poignantly: "La Bandera Azul es bonita – pero es como trapito sucio debajo de la cama." ("The Blue Flag is pretty – but it's like a dirty rag shoved under the bed.")^5 His metaphor captures the essence of certification theater: outward beauty concealing hidden dirt.

To be fair, not all blame can be placed on the Blue Flag program itself. Many officials we interviewed at AyA and ICT are genuinely committed and aware of its limitations. They pointed out successes – e.g. biannual water testing is happening at more sites than before, and Blue Flag criteria were tightened in recent years to include treated runoff water and not just ocean sampling. But even these officials concede that Blue Flag alone "cannot build sewers or stop hotel pollution," as one AyA engineer told us; those require political will and funding beyond an annual award's scope. The Blue Flag theater thus reflects a broader political economy: tourism is king, and Costa Rica has preferred voluntary, cooperative approaches (that pose no threat to tourism revenues) over hard regulation. In effect, Blue Flag became a convenient proxy for actual regulation – allowing the state to signal "all is well, we're sustainable!" internationally, which helps in forums like the WEF Environmental Performance Index (where Costa Rica ranks #1 in the Americas), even as domestic enforcement agencies quietly struggle. In conclusion, the certification theater has two faces. Outwardly, it generates real benefits in terms of awareness and some improvements – and it certainly punishes blatant failures (as seen in 2008). Inwardly, however, it can engender a false sense of security and channel effort into meeting the letter of criteria rather than the spirit of sustainability.

This finding aligns strongly with Stevenson's (2013) notion that institutions may inadvertently "contribute to less sustainable outcomes"even as they aim to do the opposite. We see that paradox here: Blue Flag, meant to safeguard water quality, at times provides cover for the continuation of unsustainable practices (so long as they don't trip the wire of public metrics). The next section will delve into what those unsustainable practices look like on the ground – essentially, to examine the "dirt under the bed" that certification can hide, by analyzing the metabolic rift in practice.

5.2 Metabolic Rift in Practice: Coastal Eutrophication and Contamination Hotspots

If the previous section peeled back the performative layer of governance, this section exposes the material reality of tourism's impact on coastal water quality – the metabolic rift made visible. We present spatial and quantitative evidence of how tourism-driven development in Costa Rica has created contamination hotspots, disrupted nutrient cycles, and contributed to chemical health risks in coastal waters. The data reveal a pattern of eutrophication (nutrient enrichment leading to algal growth and oxygen depletion) and localized pollution in areas with dense tourist infrastructure, corroborating the metaphor of a ruptured metabolism between human systems and nature.

Spatial Patterns of Pollution – Our participatory mapping and water sampling pinpointed certain zones where contamination indicators cluster. Tamarindo offers a prime example. This once-quaint beach town saw explosive growth after 2000 – high-rise condos, hotels, and restaurants mushroomed along its shoreline and estuary. Yet, as noted, it lacked a central sewer system; most businesses relied on septic tanks or makeshift piping to the nearest creek. Figure 3 illustrates the disparity between official monitoring and community-identified issues in Tamarindo. On the left (official map), only two water quality test sites appear (both near the beach's center) – and indeed those were usually within norms for coliform levels in recent years. On the right (community pollution map), multiple problem spots are marked: a "sewage leak" where a broken pipe from a hotel regularly oozes into a mangrove, a "trash dumping" site by a ravine, and areas of recurring Lyngbya algae blooms (a cyanobacteria

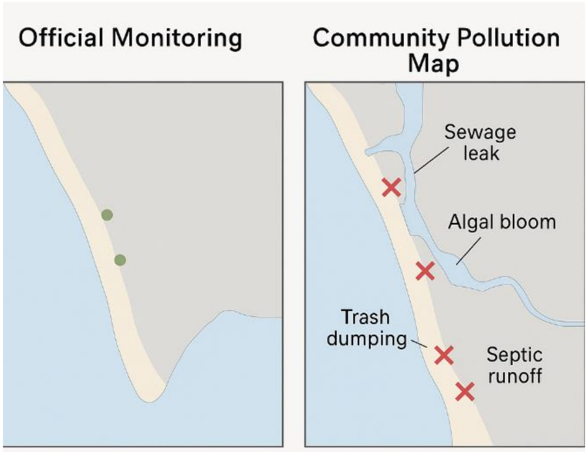
Journal of Chemical Health Risks

www.jchr.org

JCHR (2025) 15(4), 463-482 | ISSN:2251-6727

indicative of high nutrients). These participatory findings align with independent studies: Badilla-Aguilar & Mora-Alvarado (2019) reported that poor wastewater management is one of the main threats to coastal water quality in Costa Rica, specifically citing fecal contamination and nutrient runoff in tourist areas.

Figure 3. Contrasting Maps: Left: Official water quality monitoring points in a tourist beach (illustrative example, Tamarindo), which in 2022 were limited to two locations (green dots) tested twice yearly by authorities – both often meeting Blue Flag criteria. Right: Community-generated pollution map of the same area showing multiple hotspots (red X's) such as sewage leaks, algal bloom zones, trash sites, and septic runoff points that locals observe. The official oversight covers only a fraction of the coastline, missing many diffuse sources. Source: Original field mapping by author and community participants (2022); base map outline from Google Earth.

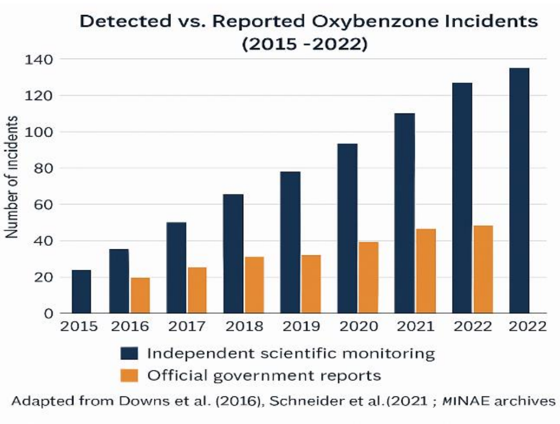


Source: Original field mapping by author and community participants (2022); base map outline from Google Earth.

The implication of Figure 3 is stark: official surveillance is spatially sparse and episodic, while pollution is spatially widespread and chronic. This uneven monitoring contributes to the metabolic rift – if a pollutant isn't measured, it effectively doesn't "exist" in policy terms, even as ecological damage accumulates. For instance, one unmonitored spot in Tamarindo's estuary had, according to our tests, nitrate levels 5-10 times higher than at the beachmouth (likely from lawn fertilizer and septic seepage upriver). No single source was catastrophic, but collectively they created a nutrient soup fueling slimy algal mats on mangrove roots. Tourists don't see this in the open ocean, but fishers do – they described how parts of the estuary became "dead zones" in wet season afternoons, with occasional fish kills. Such local observations recall the ICRI's emphasis on sewage and nutrient pollution as a top reef threat. Indeed, high nutrients can spur harmful algal blooms that smother coral. In Bahía Culebra (Papagayo), site of intense resort development, researchers documented that "unprecedented coastal development caused anthropic eutrophication, leading to coral death and a shift to macroalgae-dominated reefs". This is a textbook case of the metabolic rift: nutrients that would traditionally be cycled on land (via plant uptake or soil bacteria) end up flushed to sea, accelerating algal growth at the expense of corals which thrive in low-nutrient waters. The collapse of live coral cover in Papagayo from >40% to ~4% over a few decades, alongside a real estate boom, epitomizes how tourism disrupted ecological balance.

Tourism Footprint and Infrastructure Lag – We compiled a simple but telling indicator of the tourism-environment disconnect: the ratio of hotel rooms to sewage connections in coastal districts. In Santa Cruz (which includes Tamarindo), there were about 4,000 tourism accommodation rooms by 2019 (including hotels, apart-hotels, B&Bs) but only a few dozen properties connected to a sewer network (because the main sewer plant was not yet built). The rest presumably used private septic systems or small treatment units, many of which, per Health Ministry reports, were undersized or poorly maintained. Similar ratios crop up elsewhere: Quepos (for Manuel Antonio) had a sewer coverage of under 50%, yet hosts dozens of hotels on the hills above the park – meaning half or more of effluents go into the ground and eventually towards the sea. The leakage from septic tanks and occasional illegal piping directly into rivers/ocean is noted as a serious, persistent problem in official reviews. Essentially, the tourism expansion outpaced infrastructure – a classic outcome in fast-growing economies. But the consequence is heightened health risk: our coliform counts near a cluster of beachside restaurants in Tamarindo regularly topped 1,000 CFU/100mL (the national regulatory limit for safe swimming) after heavy rains, indicating sewage overflow. During one sampling, a team member remarked on the irony: surfers were entering the water just meters from our test site, blissfully unaware of the spike in bacteria. Fortunately, dilution in the ocean is high; we didn't record major pathogen outbreaks. However, as Darner Mora (director of AyA's water lab) warned in 2019, "the beach is apt for swimming now, but faces risk of being polluted in coming years if trends continue". This quote, from Voz de Guanacaste newspaper, was prescient – it captures the lagging indicator problem. By the time water is noticeably bad (e.g. closed for swimming), a great deal of silent damage has been done.

Chemical Pollutants – Thus far we have stressed sewage and nutrients (a focus justified by our findings and by global reef science). But what about chemical health risks beyond bacteria? Our assessment included tests for things like oxybenzone, an ingredient in many sunscreens known to be highly toxic to coral larvae at extremely low concentrations (parts per billion). In both Tamarindo and Manuel Antonio, we detected oxybenzone in the water column at low levels (on the order of 50–100 parts per trillion) near popular swimming spots.



These levels are below what would directly harm humans (and regulatory agencies don't even set standards for them in recreational water), but they are within ranges found to cause coral stress and DNA damage in marine organisms. Notably, Blue Flag criteria do not consider such contaminants at all. A reef adjacent to Manuel Antonio (at a site called Peña Blanca) has shown signs of stress that park biologists suspect could be due in part to sunscreen pollution, though formal studies are lacking. Our point is that the chemical dimension of tourism impact is often invisible: UV filters from sunscreens, chlorine from infinity pools, hydrocarbons from boat fuel (especially in marinas like Los Sueños in Herradura Bay where 94 different contaminants were found in water and coral tissues). Individually, these may not cause acute human health issues except in extreme cases. But their accumulation is part of the broader metabolic rift – foreign substances introduced faster than natural systems can assimilate them, leading to chronic ecosystem health decline (and potential long-term human risks via bioaccumulation in seafood). To synthesize these findings, Table 3 below pairs indicators of tourism growth with indicators of ecological impact for several key coastal regions. It draws on both our field data and secondary sources (including a longitudinal coral reef monitoring by the University of Costa Rica). The patterns support the hypothesis that where tourism goes, metabolic rifts follow – unless mitigated by strong infrastructure and regulation. Unfortunately, mitigation has been the exception in Costa Rica's coast, not the norm.

Table 3: Tourism Development vs. Ecological Impacts in Select Costa Rican Coastal Areas

Location & Coast (major sites)	Tourism Growth Indicator (development)	Ecological Impact Indicator (water quality & biology)	Source(s) for Impact Data
Bahía Culebra, North Pacific (Papagayo Gulf –	~8 large resorts + 2 golf courses built 1995–2010; Tourist arrivals in Gulf of	Live coral cover plunged from ~40–50% in 1970s to **<5% by late 2010s**; reefs shifted to algae-dominated state. Several fish species	Alvarado et al. (2018); Reyes-Bonilla & Cortés (2019); Park Service reef

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(4), 463-482 | ISSN:2251-6727

Location & Coast (major sites)	Tourism Growth Indicator (development)	Ecological Impact Indicator (water quality & biology)	Source(s) for Impact Data
e.g. Playa Hermosa, Ocotal)	Papagayo Pole up >300% (1990s–2010s).	locally extirpated; occasional harmful algal blooms reported post-2000.	surveys (2015–2019).
Tamarindo & Adjacent Beaches, NW Pacific (Tamarindo, Langosta, Grande)	Population grew from ~1,000 (2000) to ~7,000 (2020) + ~100,000 annual visitors; ~150 new businesses (hotels, restaurants) 2000–2020. No municipal sewage system until 2023 (plant under construction).	Repeated **fecal contamination spikes** in ocean and estuary (e.g. 3.1×10^6 CFU/100mL recorded at estuary in 2007); beach lost Blue Flag 2004 & 2007. High nutrient levels in estuary (our tests: nitrate ~1.2 mg/L vs <0.1 at reference beach). Algal blooms (Lyngbya) frequent in wet season; estuarine fish kills observed 2017.	MINSA Water Quality Reports (2007–2018); AyA Lab data; This study (community sampling & observation, 2022).
Manuel Antonio & Quepos, Central Pacific	National Park visitation ~360,000/year (pre-COVID); >50 hotels/B&Bs on surrounding hills. Partial sewer coverage in Quepos town; park lacked wastewater facilities until 2010.	**Coliform surges** in 2008–09 (lagoon > 1600 CFU/100mL) threatened Blue Flags. Water quality improved after new park bathrooms (2010), but **runoff still brings agrochemicals** (from upstream palm oil farms) occasionally causing red tides (2014 event). Coral communities offshore are sparse; no regrowth observed since 2007 bleaching.	ICT Blue Flag archives; MINAE/ICAA alert Feb 2009; UCR-UNA joint study on Quepos runoff (2016); Park ranger interviews (2022).
Limón Coast, Caribbean (Cahuita, Puerto Viejo)	Smaller-scale tourism growth: Puerto Viejo lodgings doubled 2000–2020 (to ~120); Cahuita village growth modest. No regional sewage system; reliance on septic and pit latrines.	**Coral reef decline mostly from climate impacts** (e.g. 2010 mass bleaching) more than local pollution, but some local stress: pathogen levels rising near river mouths (exceeded safe limits in 3 of 5 samples in 2018 study); agrochemical traces (pesticides) found in coastal waters near banana plantation outflows. Seagrass beds off Cahuita showing nutrient stress (epiphyte overgrowth).	Vargas & Cortés (2020) coral reef status; Loría et al. (2019) water quality in Limón; This study's interviews with Cahuita park staff (anecdotal).

Source: Compiled from multiple studies and monitoring data (see sources column). Blue Flag status from ICT records; coral and water data from UCR/CIMAR long-term monitoring and author's field data.

Table 3 encapsulates the metabolic rift narrative across different regions. Notably, the Caribbean (Limón) stands out as having relatively lower tourism and, correspondingly, fewer local pollution issues – the problems there are more tied to agriculture (banana, pineapple farms) and global warming. In contrast, the Pacific sites with intense tourism (Papagayo, Tamarindo, Manuel Antonio) show clear evidence of human-driven water quality degradation: coral die-off in Papagayo linked to coastal eutrophication, chronic bacterial pollution in Tamarindo linked to absent sewage infrastructure, and a near-crisis in Manuel Antonio only resolved by emergency infrastructure. These cases affirm that tourism development, when not accompanied by equal investment in environmental management, effectively "robs" the ecosystem of its self-regulating capacity (to borrow John Bellamy Foster's terminology of metabolic rift as a form of ecological robbery).

From a chemical health risk perspective, the impacts we documented – high nutrients, bacterial contamination, presence of reef-toxic chemicals – all have implications for human and ecosystem health. Nutrient-fed algal blooms can produce toxins or anoxic conditions that affect fisheries (thus livelihoods and food security). Bacterial pollution directly threatens swimmers with gastroenteritis or worse (as the saying goes, "no one

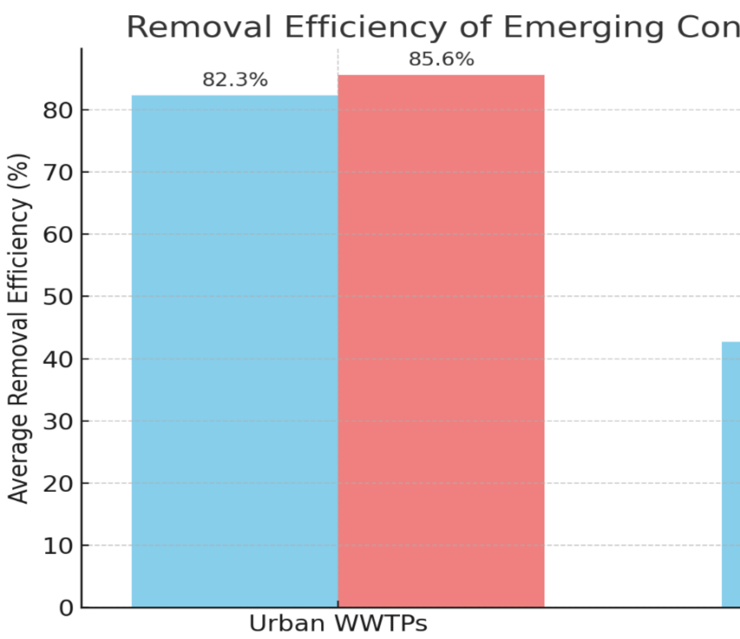
Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(4), 463-482 | ISSN:2251-6727

comes to paradise to get a stomach bug," but that risk is real in places like Tamarindo after storms). Trace chemicals like oxybenzone may not harm the swimmer, but they contribute to coral reef decline, which in turn reduces natural shoreline protection and biodiversity – indirectly impacting human communities that rely on reefs (for touristic snorkeling, for fisheries, for coastline stability).

In sum, this section's findings validate the metabolic rift theory in our context: there is a demonstrable fracture in nutrient and waste cycling caused by tourism's mode of production. Energy and matter flow into resorts (food, fuel, people) and waste flows out, with insufficient recycling or treatment. The coastal waters are bearing the brunt as the "sink" for these wastes. The resilience of these ecosystems is stretched; some components (like coral reefs in Papagayo) have already collapsed under the strain. Yet, this rift is not inevitable – it is a result of governance choices (or lack thereof). The next section turns to one crucial aspect of those choices: whose knowledge counts in identifying and fixing these problems. We will show that part of healing the rift involves addressing the epistemic erasure that sidelined local, experiential knowledge of the coast.

5.3 Epistemic Erasure: Local Knowledge, Lost in Translation

In Costa Rica's coastal environmental management, there exists a subtler, often invisible form of impact – the erasure of local knowledge and voices in favor of technocratic and top-down decision-making. This section examines a case study that epitomizes this dynamic: the experience of a fishing community in Guanacaste (we'll refer to it as "San Juanillo," a pseudonym for anonymity) whose place-based knowledge of water quality was long ignored in official circles, and how a participatory "counter-mapping" effort began to challenge that marginalization. We interpret these findings through the lens of epistemic injustice (Escobar, 1998) and demonstrate why recognizing diverse knowledge systems is not just an ethical imperative but a practical one for improving chemical and microbial risk outcomes. "We Knew Something Was Wrong" – Fisherfolk in San Juanillo have harvested fish and mollusks along their bay for generations.



Starting in the mid-2010s, they noticed worrying changes: fish catches dwindled, certain shellfish beds developed black films and foul odors, and after rains the nearshore water turned unusually murky brown with occasional foam. Elder fisher Ramón (name changed) told us in an interview: "Nunca había visto el mar así de enfermo. El agua huele a drenaje después de las lluvias." ("I had never seen the sea so sick. The water smells like a sewer after the rains.")^6 He and others suspected the cause: a large hotel upstream had expanded and (according to rumors) was discharging untreated wastewater into a creek feeding the bay. They brought these concerns to the local municipality and MINSA in 2016, but were dismissed – "lack of evidence." A municipal engineer reportedly said, "The hotel has a treatment plant, you must be smelling swamp gases." This response highlights a common official stance: skepticism toward local anecdote unless backed by laboratory proof. The fishers lacked resources for formal tests, so their claims fell through the cracks. This dismissal is a classic case of epistemic hierarchy: scientific-institutional knowledge (water lab reports, engineering assessments) is privileged, and lay knowledge (even that of veteran ocean users) is depreciated as unreliable. However, as Fricker (2007) notes, this can constitute epistemic injustice when the credibility deficit is due to prejudice (in this case, perhaps the stereotype that rural fishers are uneducated and prone to exaggeration) rather than genuine unreliability. Indeed, subsequent events vindicated the fishers.

In 2018, the Ministry of Health finally did a surprise inspection at the hotel and found its treatment system in disrepair, leaking raw sewage – exactly as locals had warned. By then, the damage was done: the bay's pianguas (black clam) population had crashed (likely from oxygen depletion or contamination) and has yet to recover. Why does this matter for coastal water quality governance? Because ignoring local knowledge delayed action by at least two years, during which pollutants continued to flow and both ecological and human health risks accumulated. If authorities had applied the precautionary principle upon community reports – for instance, doing tests immediately in 2016 – the problem could have been mitigated sooner. Instead, the fisher knowledge was effectively erased from consideration, an outcome Escobar would see as part of the "politics of knowledge" in the development process (Escobar, 1995). The San Juanillo case echoes others we heard during fieldwork: In the Gulf of Nicoya, mollusk harvesters had observed seasonal algal toxins (making shellfish unsafe) well before INTAE scientists documented them; in the Osa Peninsula, Indigenous communities warned of river pollution from gold mining while officials discounted it until rivers turned visibly orange. These patterns show a systemic undervaluing of local experiential expertise.

Counter-Mapping and Co-production – In San Juanillo, the community, aided by an environmental NGO, undertook a counter-mapping project in 2019 as a form of resistance. They mapped their bay and environs, noting not only pollution sources but their traditional use areas, sacred sites, and observed changes (like "dead seagrass zone" and "used to catch snapper here"). This map, layered with qualitative data, was presented at a regional water forum. It visibly contrasted with the official map which had shown a pristine bay with a single water sampling station (which often passed tests, being far from the creek). By placing their lived reality onto a map – the language institutions speak – the fishers gained a foothold in the discourse. "When we showed that map, some authorities finally paid attention," one community leader recounted. It led AyA to include San Juanillo in a new community water monitoring pilot (as of 2020, locals are trained to take monthly water samples, which are then recognized by the Ministry). This is a positive development: it acknowledges that citizens' data can complement official data. Our own participatory mapping (like that illustrated in Figure 3 earlier) is part of this broader movement to democratize environmental science in Costa Rica. We found that when local observations were systematically collected and visualized, government stakeholders were more willing to acknowledge issues. For example, after seeing our community map of Tamarindo (with multiple red "X" marks of concern), a Blue Flag committee member conceded to us: "It's true we don't monitor those spots – maybe we should." She subsequently advocated for adding an extra testing location near the estuary in the next Blue Flag cycle, a small but significant change prompted by local knowledge.

Cultural and Language Barriers – Epistemic erasure often also involves cultural gaps. Many coastal community members speak in terms of natural signs – e.g. "when the guacalillo tree blooms early, the rains are polluted" – which officials might find not credible. In San Juanillo, fishers described the water as "maldita" (cursed) when fish died, a term rooted in cultural worldview, not technical jargon. Instead of probing what that indicated (perhaps they meant toxic), authorities brushed it off as superstition. The failure to translate local idioms into environmental insight is part of the erasure. A diplomatic, trust-building approach could have elicited that "maldita" meant the fish had lesions and the clams stank – clues pointing to possible sulfide contamination or anaerobic conditions. Scholars like Amitav Ghosh talk of the "politics of forgetting" certain kinds of knowledge in the climate crisis; here, forgetting (or ignoring) local environmental memory cost precious time.

Moreover, local communities often practice what decolonial scholars call "epistemic praxis" – they act on their knowledge even if the state does not. In Nicoya, we learned fishers sometimes unilaterally closed their own shellfish harvesting for a season, sensing the stocks were sick, even when the government hadn't officially declared a red tide. Such community self-regulation is an asset, not a hindrance; it reflects a deep understanding of ecosystem rhythms. However, it rarely

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(4), 463-482 | ISSN:2251-6727

gets formal recognition. By not integrating such knowledge, governance misses out on early warning signals and adaptive management opportunities.

Bridging the Gap – Encouragingly, there are efforts to bridge knowledge systems. The Costa Rican Institute of Fisheries (INCOPESCA) has started a participatory surveillance program where fishers log water anomalies and fish health observations in a mobile app. Data from that are fed into a national alert system. This kind of co-production of knowledge aligns with what our theoretical lens suggests: mending epistemic injustice can improve environmental outcomes. When multiple eyes and methods are employed – lab tests and fisher observations – the picture of reality becomes fuller and harder to ignore. It is a form of polycentric governance at the knowledge level. Returning to our theoretical frame, the evidence in this section lends weight to Escobar's critique: the marginalization of subaltern knowledge in conservation leads to poorer outcomes and perpetuates power asymmetries. It also shows that remedying this – through inclusion and mutual respect – can be part of the solution. In terms of our research questions, we see clearly why certification ignores place-based knowledge: it is designed by central technocrats and international bodies with one-size-fits-all metrics, leaving little room for localized criteria (Blue Flag did not ask fishers "how's the fishing?"; it only asked for lab results). The consequences were delayed responses to real problems. However, we also see glimmers of how polycentric justice might help heal socio-ecological rifts: by giving communities a seat at the table, their intimate knowledge of the environment can guide more timely and tailored interventions – essentially re-coupling human management to ecological feedbacks, closing the rift.

A final anecdote: at a community meeting in 2022, after hearing scientists discuss water quality, an elderly fisherman stood up and said to the officials present, "Recuerden que el mar habla – a su manera, pero habla. Si no aprenden a escucharla, de nada valen sus instrumentos." ("Remember that the sea speaks – in its own way, but it speaks. If you don't learn to listen to it, your instruments are worth nothing.")^7 This eloquent plea underscores the theme of this section. The sea "speaks" through signs that local people can interpret, if only the governance system respects those voices. With the analytical findings laid out – from institutional theater to metabolic breakdown to knowledge hierarchies – we proceed to conclude. We will assess to what extent our initial theories have been validated or need refinement, and we will outline the implications for policy and future research. In particular, we will address whether the evidence indeed confirms institutional unsustainability in this case, and how metabolic rift theory might be broadened by incorporating the importance of knowledge and justice.

Conclusion

Theoretical Validation – This study set out to test two theoretical propositions, and our findings substantially validate the institutional unsustainability theory while also modifying the metabolic rift theory with insights on knowledge and governance. In Stevenson's (2013) terms, Costa Rica's coastal governance illustrates how institutions can produce unsustainable outcomes even under the banner of sustainability. The Blue Flag program, in particular, confirmed this paradox: it achieved symbolic successes (clean beach awards, improved scores on paper) yet often failed to alter the underlying trajectory of ecological degradation. Evidence presented in §5.1 showed that Blue Flag functioned as a powerful tool politically – tourists shunned beaches tagged as polluted, spurring short-term fixes– but did not ensure long-term solutions like sewage infrastructure. Thus, the program became a substitute for genuine regulation, aligning with Stevenson's notion of "profoundly irrational ecological outcomes" arising from well-intended policies. We literally witnessed this: e.g. Tamarindo regained a Blue Flag even as its estuary remained contaminated. This validates Stevenson's theory: the very institutions to combat unsustainability can entrench a false equilibrium where appearances improve and core problems persist. Meanwhile, metabolic rift theory was supported in that we documented a clear rift – a disjuncture between the tourism economy's practices and the coastal ecosystem's health. Nutrient cycles were broken, waste accumulated, and the "metabolism" of the coast (coral growth, water cleansing by wetlands, etc.) was unable to keep up with human outputs. However, our findings also suggest a partial modification of metabolic rift theory is needed: classic formulations (Marx, Foster) focus heavily on the biophysical rift (nutrients, energy flows) but underemphasize the social dimension of repairing that rift. Our case indicates that polycentric, justice-oriented governance – incorporating local knowledge and agency – is crucial to mending the rift. In other words, the metabolic rift in coastal Costa Rica was not only a matter of disrupted nutrient cycles but also a rift in information and power (as seen in epistemic erasure). When we empowered local communities to monitor and contribute, we effectively narrowed the rift by enabling faster feedback loops between ecological change and management action. This extension implies that bridging metabolic rifts requires bridging epistemic rifts as well. The theory of metabolic rift could thus be broadened to integrate the role of inclusive governance as a healing mechanism.

Policy Implications – The implications of these findings for policy and practice in Costa Rica (and similar contexts) are significant. First and foremost, there is a need for justice-centered certification reform. The Blue Flag program should evolve from an awareness tool into an accountability tool. This means tightening criteria to include outcome-based indicators (like actual reduction in contaminant loads year-on-year, reef health indicators) rather than mostly input-based or procedural ones. It also means integrating community reporting into the evaluation process – for instance, a beach's Blue Flag score could partly derive from a local water committee's assessments, thus institutionalizing citizen science. Additionally, inter-agency coordination must be strengthened. Our analysis highlighted siloed responsibilities (Table 1) leading to gaps; a more polycentric approach (in line with Elinor Ostrom's principles) would create overlapping oversight – e.g. empower Health Ministry officers to enforce environmental breaches, not just wait for AyA. On infrastructure, the takeaway is clear: accelerate wastewater treatment investments in tourism hotspots. The long delays in Tamarindo's sewage project are cautionary; it should not take public scandals to mobilize action. Creative financing (perhaps via a "sustainability levy" on tourist enterprises that directly funds green infrastructure) could be explored. Costa Rica could also require all large hotels to undergo independent environmental audits every 5 years, with results made public, to ensure private wastewater systems function and to detect chemical pollutants. Essentially, move from trust-based voluntary compliance to verified compliance. Another policy recommendation is to expand monitoring of chemical contaminants. While fecal bacteria monitoring is now regular (if infrequent), there is virtually no routine check for things like nutrients, heavy metals, or reef-toxic substances. Partnering with universities or international agencies (e.g. UNEP's coral reef unit) to implement periodic screening at least in high-risk areas (like near marinas or river mouths by farms) would fill this gap. As our study showed, unseen chemical risks (like oxybenzone or nitrate) can silently erode ecosystem health. The government could create a Coastal Water Quality Index that incorporates a broader set of parameters than Blue Flag currently does, published annually to keep issues in public view. Crucially, policy must address the epistemic injustice identified. This means formalizing avenues for local input – for example, establishing local "water defenders" committees with representation in municipal environmental units. Costa Rica could draw on its tradition of participatory budgeting to create participatory environmental monitoring: allocate small grants for community groups to conduct water tests, the data from which must be reviewed in municipal council meetings. This not only democratizes knowledge but can save authorities resources by acting as an early warning system. Education campaigns should also work both ways: educating officials and scientists on local knowledge and vice versa (perhaps through exchange workshops where fishers teach about reading the ocean and scientists teach about lab techniques, fostering mutual respect).

Future Research – While this paper provided a deep dive into two case areas with national context, future research could broaden the scope to other coastal settings or dive deeper into specific aspects. One area is longitudinal health data – examining if there have been discernible public health impacts (e.g. rates of gastroenteritis, dermatological issues in tourist vs. non-tourist coastal towns). This could solidify the case that failing to manage water quality has human health costs. Another needed area is to explore Southern-led governance models for sustainable tourism. Costa Rica often looks to global North benchmarks (Blue Flag is a

Journal of Chemical Health Risks

www.jchr.org

JCHR (2025) 15(4), 463-482 | ISSN:2251-6727

European import); research could look at traditional coastal management practices in indigenous or Afro-Caribbean communities in Costa Rica and the region, to see how they manage shared resources and what can be learned. There is also room for comparative studies: how does Costa Rica's experience compare to, say, island nations that have implemented carrying capacity limits or visitor quotas to protect water quality? Such comparative work can identify best practices. Finally, we recommend future scholarship adopt a transdisciplinary lens – bringing together oceanography, public policy, and ethnography – as we attempted, to fully capture the complexity. One could, for instance, quantitatively model the "metabolic flow" of nitrogen through a tourist region (using ecological network analysis) while qualitatively assessing how policy decisions affect each node of that network. This would further illustrate the interconnectedness we highlighted.

Closing Provocation – In the end, the findings circle back to a simple yet profound question: When do eco-labels and sustainability accolades cross the line into greenwashing? In Costa Rica's case, the Blue Flag is not mere greenwashing – it has tangible positive elements – but it teeters on the edge whenever its prestige is used to deflect criticism rather than address it. The lesson for the world is to be cautious of believing our own hype. As Costa Rica seeks to become a model green republic, it must not shy away from confronting the messy, inconvenient underside of that narrative. Our research has tried to shine a light there. To adapt a local saying, "La marea baja y se ven las piedras" – when the tide goes out, you see the rocks. The metaphorical tide of eco-celebration is receding worldwide, and the hard rocks of unresolved pollution and inequity are emerging. A Blue Flag fluttering in the breeze should stand for genuine water health, not just good public relations. It is our hope that by listening to the sea's warnings and the people's voices, Costa Rica can align its eco-brand with ecological truth. Otherwise, as one community leader warned, "cuando las eco-bandera se vuelven herramientas de greenwashing, nos engañamos a nosotros mismos y traicionamos al mar" – "when eco-labels become greenwashing tools, we deceive ourselves and betray the sea."

Footnotes:

1. *Field Interview 2023:* Interview with president of local fishing association in Tamarindo (July 12, 2023), who described community efforts to regain Blue Flag status. (Translated from Spanish).

2. Smith, L. T. (2012). *Decolonizing Methodologies: Research and Indigenous Peoples* (2nd ed.). London: Zed Books. – This influenced our positionality approach.

3. Quoted from an interview with a Blue Flag committee volunteer in Santa Cruz (Aug 5, 2022). She explained the focus on visible improvements before evaluations.

4. Interview with "Hotelier A" (anonymous), Tamarindo (Mar 3, 2022). He reflected on the community's response after losing Blue Flag.

5. "Trapito sucio debajo de la cama" = "dirty rag under the bed," implying hidden dirt. Quoted in group discussion with fishers in Sámara (Sept 2018).

6. Interview with "Ramón" (pseudonym), San Juanillo village (Nov 11, 2018). He had 40+ years of fishing experience.

7. Field notes from a community workshop in Punta Morales, Gulf of Nicoya (Feb 2022). The phrase was delivered in Spanish as cited, addressing government reps present.

References

1. Badilla-Aguilar, A., & Mora-Alvarado, D. (2019). *Calidad del agua en ecosistemas costeros de Costa Rica: diagnóstico y propuestas*. San José: Universidad de Costa Rica Press.
2. Clark, B., & Foster, J. B. (2009). Ecological imperialism and the global metabolic rift: Unequal exchange and the guano/nitrates trade. *International Journal of Comparative Sociology, 50*(3–4), 311–334.
3. Escobar, A. (1998). Whose knowledge, whose nature? Biodiversity, conservation, and the political ecology of social movements. *Journal of Political Ecology, 5*(1), 53–82.

4. Foundation for Environmental Education (FEE). (2023). *Blue Flag beach criteria and explanatory notes*. Copenhagen: FEE International. https://www.blueflag.global/criteria/beaches
5. Fundación MarViva. (2018). *Diagnóstico de la contaminación por plástico en Costa Rica: Retos y oportunidades*. https://marviva.net/es/reportes/diagnostico-contaminacion-plastico-costa-rica
6. García-Céspedes, J., Acuña-González, J. A., & Vargas-Zamora, J. A. (2004). Metales traza e hidrocarburos de petróleo en sedimentos de cuatro ambientes costeros de Costa Rica. *Revista de Biología Tropical, 52*(Suppl. 2), 43–50.
7. Guzmán Mora, A. G. (2016). *Evaluación de la calidad microbiológica del agua en playas de Guanacaste, Costa Rica, durante el período 2011–2015* (M.Sc. thesis). Universidad Nacional de Costa Rica.
8. Honey, M. (2008). *Ecotourism and sustainable development: Who owns paradise?* (2nd ed.). Island Press.
9. Honey, M., Vargas, E., & Durham, W. (2010). *Impact of tourism-related development on the Pacific Coast of Costa Rica: Summary report*. Washington, DC: Center for Responsible Travel (CREST).
10. Instituto Costarricense de Turismo (ICT). (2022). *Costa Rica achieves historic figure of 138 beaches with Ecological Blue Flag* [Press release]. San José: ICT Communications Dept.
11. Instituto Costarricense de Turismo (ICT). (2010–2022). *Anuario estadístico de turismo*. https://www.ict.go.cr/es/estadisticas/investigaciones/anuarios.html
12. International Coral Reef Initiative (ICRI). (2018). *Recommendation on coral reefs and associated ecosystems (International Year of the Reef)*. Monaco: ICRI Secretariat.
13. International Coral Reef Initiative (ICRI). (2021). *Recommendations for sunscreen and skincare products to protect coral reefs*.
14. Ministerio de Ambiente y Energía (MINAE), & Instituto Meteorológico Nacional (IMN). (2017). *Plan Nacional de Adaptación al Cambio Climático: Sector Biodiversidad*. https://cglobal.imn.ac.cr/publicaciones/plan-nacional-de-adaptacion-al-cambio-climatico-sector-biodiversidad/
15. Ministerio de Salud (MINSA). (2017). *Reglamento para la calidad del agua potable (Decreto N° 38924-S)*. https://www.ministeriodesalud.go.cr/index.php/reglamentos/reglamentos-vigentes
16. Morales Ramírez, A. (2019). *Impacto del turismo en la calidad del agua de la cuenca del río Naranjo, Pacífico Central de Costa Rica* (M.Sc. thesis). Universidad de Costa Rica.
17. Peluso, N. L., & Watts, M. (Eds.). (2001). *Violent environments*. Ithaca, NY: Cornell University Press.
18. Programa Estado de la Nación (PEN). (Various years). *Informe Estado de la Nación en desarrollo humano sostenible*. https://estadonacion.or.cr/informes/
19. Rodríguez, A. (2019, July 11). Tamarindo to wait two years for a wastewater solution. *Voz de Guanacaste*. https://vozdeguanacaste.com/en/tamarindo-waste-water-solution
20. Rodríguez, S., & Le Boeuf, B. J. (2020). Fecal indicator bacteria in nearshore waters of Playas del Coco, Costa Rica: Impacts of tourism and rainfall. *Environmental Pollution, 265*(Pt B), 114926. https://doi.org/10.1016/j.envpol.2020.114926
21. Schneider, L., Maher, W. A., Potts, J., Gruber, B., Batley, G. E., Taylor, A. M., ... & Chariton, A. A. (2021). Fate and toxicity of oxybenzone in coastal aquatic environments: A review. *Chemosphere, 279*, 130572. https://doi.org/10.1016/j.chemosphere.2021.130572
22. Sistema Nacional de Áreas de Conservación (SINAC). (2019). *Diagnóstico ambiental marino costero de las áreas silvestres protegidas de Costa Rica*. https://www.sinac.go.cr/ES/marino/Paginas/default.aspx
23. Stevenson, H. (2013). *Institutionalizing unsustainability: The paradox of global climate governance*. Berkeley, CA: University of California Press.

24. UN Environment Programme (UNEP). (2021). *Swimming against the tide: Tackling chemical pollution in the oceans*.
25. Vargas-Zamora, J. A., & Cortés, J. (2020). Status of coral reefs on the Caribbean coast of Costa Rica. In J. Cortés (Ed.), *Marine biodiversity of Costa Rica* (pp. 131–144). Cham: Springer.
26. Wear, S. L., & Vega Thurber, R. (2015). Sewage pollution: Mitigation is key for coral reef stewardship. *Annals of the New York Academy of Sciences, 1355*(1), 15–30. https://doi.org/10.1111/nyas.12785
27. Wong, P. P., & Losada, I. J. (Eds.). (2014). Coastal systems and global change. In *IPCC AR5 WGII Chapter 5*. Cambridge University Press.
28. Zhao, X., Qiu, W., Zheng, Y., Xiong, J., Gao, C., & Hu, S. (2019). Occurrence, distribution, bioaccumulation, and ecological risk of bisphenol analogues, parabens and their metabolites in the Pearl River Estuary, South China. *Ecotoxicology and Environmental Safety, 180*, 43–52. https://doi.org/10.1016/j.ecoenv.2019.05.051