



THE KNOWLEDGE PARADOX: BRAIDING LOCAL VOICES AND GLOBAL SCIENCE IN AQUATIC CONSERVATION

Thesis for the Degree of Doctor of Philosophy (PhD)

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Debrecen, 2025

Hereby I declare that I prepared this thesis within the Doctoral Council for Natural Sciences and Engineering, Doctoral School of Juhász-Nagy Pál, University of Debrecen in order to obtain a PhD Degree in Natural Sciences at Debrecen University.

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THE KNOWLEDGE PARADOX: BRAIDING LOCAL VOICES AND GLOBAL SCIENCE IN AQUATIC CONSERVATION

Dissertation submitted in partial fulfilment of the requirements for the doctoral (PhD)
degree
in Ecology

Written by Ronald Juanito Maliao certified Marine Biologist

Prepared in the framework of the Juhász-Nagy Pál doctoral school of the University of
Debrecen
(Quantitative Ecology programme)

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The date and venue of the dissertation defence: 2025

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1| General introduction

Water is the lifeblood of landscapes and the cradle of cultures, its currents carrying sediments, species, and stories from the mountains to the sea. Yet, in the Anthropocene, this vital continuum of materials, life, and meaning is fracturing. The world's aquatic ecosystems are systematically degraded; their flows dammed, polluted, and fragmented, and their voices silenced (Dudgeon & Strayer, 2025). This triggered a biodiversity crisis felt most acutely in freshwater ecosystems. The scale of the collapse is staggering: since 1970, the biomass of monitored freshwater populations has plummeted by 83% (WWF, 2022), and today, roughly one in four freshwater species faces extinction (Sayer et al., 2025), stripping these systems of their functional complexity. Despite the surge in scientific research and high-level calls to action (Maasri et al., 2022; Arthington et al., 2023; Lynch et al., 2023) our collective efforts are failing.

For me, the study of these systems is not a detached academic exercise; it is an act of memory, rooted in the complex ecology of my homeland. The Philippines is a Malay archipelago of over 7,000 islands, situated on the Pacific Rim and within the Global South. It is the world's epicenter of marine shore fish biodiversity (Carpenter & Springer, 2005). It is from this global center of life that my personal story begins. My mother hailed from the Zamboanga Peninsula in Mindanao (*Pulu' ni Mindanaw*), a southern frontier in the Philippines known paradoxically as the Land of Promise. This title speaks not only to its rich biodiversity and vanishing *Lumad* communities (Agduma et al., 2023), but also to the broken

promises of decades of ethnic conflict and economic marginalization (Schiavo-Campo & Judd, 2005; Madrigal et al., 2025).

I grew up in the shadow of this contradiction. My mother, a proud member of the *Subanen* Indigenous Tribe whom I lost to COVID-19 on the eve of my doctoral studies in Hungary, embodied a much older promise. The Subanen are, by their very name, the “people of the river”; their identity is derived from the word *suba*, the river that is the wellspring of their culture, livelihood, and history (Sebrero, 2023). Her heritage instilled in me a firsthand understanding that when an aquatic ecosystem is degraded, the cost is not measured in ecosystem services alone; what is lost is the soul of a culture, the memory of a people, and the very meaning of home. Yet, I did not grow up where she did, nor was I immersed in her ancestral culture, as my own path led me far from the *suba*. Her death, therefore, was a dual severance. I did not just lose my mother; I lost my last living bridge to a heritage already being eroded, assimilated, and homogenized by the onslaught of time (Quilo et al., 2015; Madrigal et al., 2025). It is a profound irony, then, that in her death I have come full circle, returning to her home *suba* within the pages of a dissertation whose importance she would never grasp.

That landscape of conflict and broken promises finds a powerful echo in conservation itself. I argue that the field's persistent failure stems from a fractured approach, hindered by three conceptual divides. First, the geopolitical divide between the Global North and South creates research inequities that skew conservation priorities on the ground (Tydecks et al., 2018; Stefanoudis et al., 2021). Second, the epistemological divide between Western science and Traditional Ecological Knowledge (TEK)

dismisses place-based insights as anecdote, causing irreplaceable ecological data to be lost (Berkes et al., 2000; Molnár et al., 2024). Finally, the science-policy divide represents a chronic failure to translate empirical knowledge into effective, socially-just action that protects biodiversity (Nyssa et al., 2024). These are not abstract concepts; they are the very fractures that silenced my mother's river and devalued her heritage.

These three divides are not independent but are interlocking gears in a single machine that produces what I term the Disappearing Effect. This is the active, systemic process by which vital local knowledge and ecological realities, from subtle population shifts to untracked local extinctions, are rendered invisible, undervalued, and ultimately erased from the dominant conservation discourse. This is rooted in a North-South division manifesting as center-periphery dynamics (Marginson et al., 2023), perpetuating a cycle of epistemic injustice (Nyssa et al., 2024). In the Anthropocene, where challenges like climate change demand urgent, place-based data, this cycle is particularly devastating. It leads to interventions that are not only ineffective but can unexpectedly deepen the very problems they seek to solve (Bennett et al., 2017), locking communities into debilitating social-ecological traps (Cinner & McClanahan, 2011). This failure persists despite urgent calls from many global bodies like Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) for a more pluralistic approach to biodiversity conservation. This ultimately leaves local subsistence communities in megadiverse but data-poor regions to bear the full ecological and emotional brunt of a conservation paradigm that fails

to see them or their disappearing worlds (Maliao et al., 2009a, 2009b; Relano & Pauly, 2023).

The genesis of this dissertation was crystallized at the 2022 European Congress for Conservation Biology in Prague. There, during a symposium on riverine ecosystems, a shared sense of collective frustration over our fragmented work led to a pact: to deliberately bridge our own intellectual divides. This collaborative effort matured into a synthesis paper in *Conservation Biology* where I championed the inclusion of TEK as the empirical and metaphorical bridge for a truly integrated science (Hoppenreijs et al., 2024; Maliao et al., 2025). That experience became my lodestar, compelling a strategic pivot in my research. I chose to capitalize on the momentum of this collaboration and, crucially, on my own body of unpublished Philippine data. This synergy clarified my goal: this dissertation would not merely bridge the fractures between ways of knowing, but braid their disparate strands to heal them, forging a whole that is both more resilient and locally resonant.

The central knowledge system this dissertation engages with is Traditional Ecological Knowledge (TEK). While part of the broader umbrella of Indigenous and Local Knowledge (ILK) (Gadgil et al., 1993; Gadgil et al., 2021; Molnár & Babai, 2021; Molnár et al., 2024), TEK refers specifically to the cumulative, adaptive body of knowledge about the relationship of living beings with one another and with their environment (Berkes et al., 2000; Berkes, 2017). Far from static lore, TEK is being rediscovered as a vital toolkit for conservation, offering critical ecological data often invisible to conventional science (Johannes, 1998; Silvano et al., 2023; Molnár et al., 2024). It provides crucial

insights for tracking climate change impacts, reconstructing historical population dynamics, and enhancing community resilience. This dissertation champions TEK as a parallel and complementary scientific system essential for a more holistic and effective conservation ecology and practice.

Therefore, this dissertation diagnoses the structural inequities that obscure local ecosystem dynamics, unravels the psychological toll of witnessing trophic shift, validates Traditional Ecological Knowledge (TEK) as a rigorous tool for quantifying multi-decadal biodiversity loss, and synthesizes these findings into an integrated framework for holistic aquatic conservation. This work grounds its global argument by adopting a ridge-to-reef approach, examining the connected aquatic ecosystems in central Philippines, a global biodiversity hotspot where these conservation divides are clearly manifested (Carpenter & Springer, 2005; Maliao et al., 2025). I listen to the voices along this continuum of water, from the mountainous freshwater reaches of the Nabaoy River (the 'ridge') to the brackish wetlands of the Batan Estuary (the 'reef'), seeking in their intertwined stories a path to mend our fractured relationship with water.

My research dismantles this fractured paradigm through four interconnected findings. I diagnose the Disappearing Effect exposing structural inequities that obscure local ecological realities. I quantify the Expert's Grief, charting human sorrow as ecosystems degrade, from lost predators to a decaying fishery. Methodologically, I prove that Traditional Ecological Knowledge (TEK) is a powerful scientific lens, giving a statistical voice to aquatic ecosystems and detecting their silent degradation. I synthesize these insights into the Crumbling Bank model,

predicting how knowledge and community fractures trigger socio-ecological destabilization. Ultimately, my work proves that listening to those who know the water best reveals not just the memory of what was lost, but the empirical proof that human well-being is inseparable from the trophic health and complexity of our worlds.

The research presented in this dissertation was made possible by the generous support of several institutions and communities. The case study in Chapter 4 was funded by the Philippine government through a grant from the National Commission for Culture and the Arts (NCCA), with a portion of its data collected as part of a separate project supported by the Toyota Foundation Grant of Japan. The research in Chapters 5 and 6 was funded by the Oscar M. Lopez (OML) Center for Climate Change Adaptation and Disaster Risk Management Foundation, Inc. I am deeply grateful for these essential institutional supports. My deepest appreciation, however, is reserved for the hundreds of fishers from the coastal and riverine communities of the Batan Estuary and Nabaoy River, who willingly shared their knowledge and their stories. This work would not exist without them.

To prove the overarching thesis that emerges from these stories, this dissertation embarks on a deliberate intellectual journey. The following chapter provides the detailed roadmap, outlining the core goals, methods, and key findings of the four interconnected studies that constitute this work.

2| Goals of the dissertation, general methods and key findings

In this dissertation, I demonstrate that a cycle of epistemic marginalization in aquatic science is not just an injustice; it is a primary driver of conservation failure. My central argument is twofold. First, I demonstrate that local knowledge, often devalued as anecdote, is a rigorous framework capable of revealing multi-decadal trophic shifts invisible to conventional science. Second, I reveal that suppressing this knowledge inflicts a measurable psychological toll on its keepers, an injustice that proves the stakes of this work are not merely academic, but deeply human. This chapter provides a roadmap to the four interconnected studies that build this argument, outlining the core goals, methods, and key findings of each (see Figure 2.1).

Each chapter of this dissertation is anchored on one or more scientific publications. While my collaborative work with international researchers provided the foundational spark for this dissertation (Hoppenreijs et al., 2024), its empirical core is forged from a series of targeted, place-based studies. Though each study functions as an independent scientific inquiry, they were designed to be cohesive, forming a single, four-part argument. My dissertation's narrative arc strategically moves from a structural diagnosis of a key problem in conservation science, to its human and ecological costs, to the validation of a methodological solution, and culminates in a final synthesis.

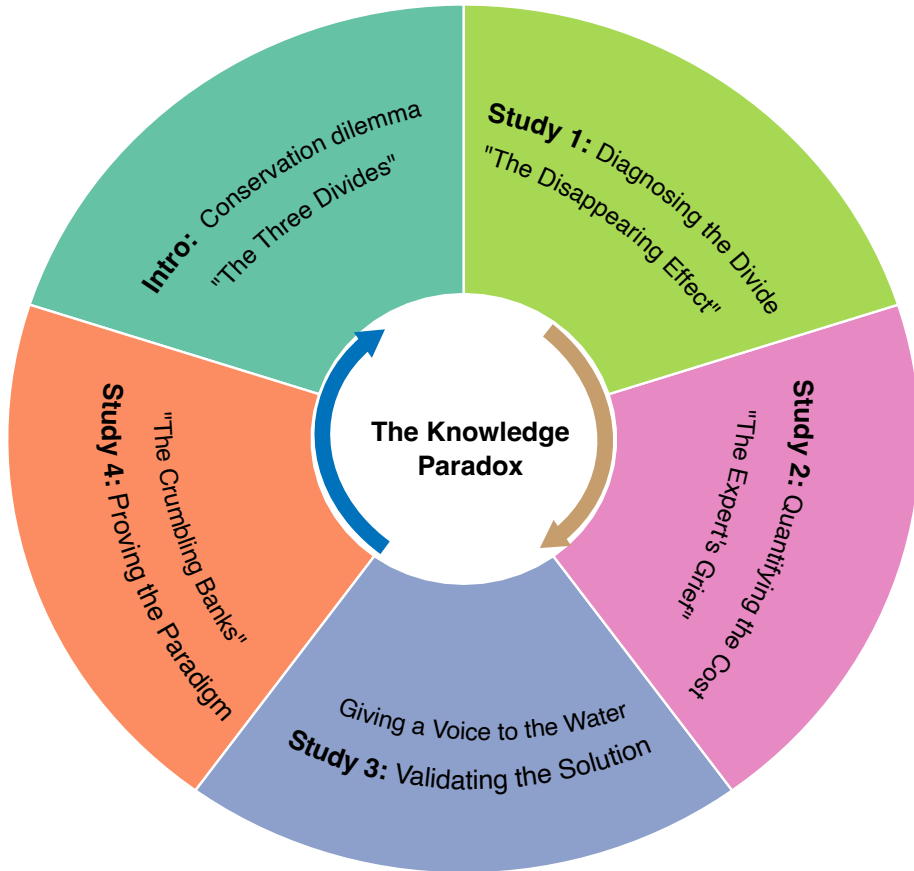


Figure 2.1 | A conceptual framework for deconstructing and mending the knowledge paradox in aquatic conservation. This dissertation follows a four-part intellectual journey to diagnose and disrupt a central knowledge paradox that drives conservation failure. The Introduction first establishes the overarching conservation paradox. Study 1 then diagnoses the structural inequities that create the Disappearing Effect. Building on this, Study 2 quantifies the profound human and ecological costs of this failure through the Expert's Grief. Study 3 then validates Traditional Ecological Knowledge (TEK) as a rigorous methodological solution, giving a voice to a silenced river. The final study, Study 4, serves as a grand synthesis, proving the paradigm of Crumbling Bank, the total social-ecological failure that results from these disconnected systems. The synthesis from this final study provides a new, integrated framework for addressing the initial paradox, thus closing the intellectual loop.

I use the Philippines not to document another case of conservation failure, but to validate a more powerful, human-centered alternative. The nation's collision of megadiversity, data-poverty, and livelihood precarity creates a crucible for demonstrating that TEK is not simply a data source, but a sophisticated epistemic framework for effective conservation. The goal of this model system approach is therefore not statistical but theoretical generalizability; following established principles of case study research (Yin, 2009; Driscoll & Lindenmeyer, 2012; Opatovsky et al., 2025). I argue that local knowledge is not merely a research method but rather a fundamental mechanism for building social-ecological resilience. This makes my findings vital for any context where a community's well-being is inseparable from the health of its ecosystem.

Study 1: Diagnosing the divide. First, I empirically diagnose the structural inequities that create conditional visibility for Global South research. Building on theories of global scientific labor division (Bradley, 2008), I hypothesized that any citation premium from international collaboration is a conditional artifact of the global evaluation system. To test this, I used a multi-stage scientometric analysis of Philippine aquatic TEK literature. The dataset for this analysis was compiled through a comprehensive systematic map, with protocols formally registered in both PROCEED and CABI (Maliao & Tóthmérész, 2025a, 2025b). My analysis reveals the Disappearing Effect: the mechanism of conditional visibility where the supposed citation premium for internationally-affiliated authors disappears entirely when the analysis is restricted to the national context. This provides robust, empirical evidence of a deep

structural bias in aquatic science, directly impacting which ecosystems and species receive scientific attention.

Study 2: Unravelling the grief. Having diagnosed the architecture of the problem, I unravel its hidden human toll. I hypothesized that local experts with deeper ecological knowledge would suffer a greater degree of solastalgia: the place-based distress caused by environmental degradation (Albrecht et al., 2007). Through a case study in a central Philippine estuary, I used decades of fisher testimony to quantify a dual erosion of both ecosystem health and community well-being. Ecologically, my TEK-based reconstruction of the fishery revealed not just a loss of biomass, but a profound structural transformation evidenced by a classic trophic shift (Pauly et al., 1998). This signals fundamental loss of the ecosystem's complexity and resilience. My key finding is a data-driven model for the Expert's Grief, a paradox where expert knowledge positively correlates with the intensity of grief. This model provides two novel contributions: the first mechanistic model of solastalgia and the first quantitative signature for the social mechanisms of Shifting Baseline Syndrome (SBS), the generational amnesia that obscures true ecological loss (Pauly, 1995; Soga & Gaston, 2024).

Study 3: Giving voice to the river. To counter the erasure and degradation documented in the first two studies, I next sought to validate Traditional Ecological Knowledge (TEK) as a rigorous methodology for tracking long-term ecological change, a high-resolution history of biodiversity loss that would otherwise be permanently lost (Pauly, 1995; Soga & Gaston, 2024). Building on foundational work that treats local testimony as valid ecological data (Johannes, 1981) I demonstrated that

aggregated local memory provides a robust methodology for quantifying a severe, multi-decadal depletion in the fishery. Ecologically, this method was sensitive enough to reveal that anurans (frogs), a key local bioindicator, exhibited the most drastic decline, a finding that aligns with global assessments of the amphibian crisis (Sayer et al., 2025). Critically, this work also revealed a novel, reverse signature of Shifting Baseline Syndrome: a catastrophic acceleration of ecological collapse so recent that even younger community members perceived a steeper decline than their elders. This work gives a statistical voice to a silenced river.

Study 4: Synthesizing the Solution. My final study serves as the grand synthesis, illustrating the concept of Crumbling Bank, the system-level failure that occurs when fragmented science ignores local realities. Following calls for more integrated, people-centered approaches (Berkes, 2004; Lynch et al., 2023), I integrated TEK on climate impacts with biodiversity data to trace the cascading collapse of the vital freshwater prawn fishery. This collapse demonstrates the dissertation's central thesis: local communities possess sophisticated knowledge of the climate impacts driving this decline; this knowledge entirely missed by formal policy. Their traditional taboo systems function as a critical form of social capital (Putnam, 2000), creating an effective, informal conservation system (Ostrom, 1990; Colding & Folke, 2001). The Crumbling Bank concept thus explains precisely how fragmented science guarantees ecological failure by ignoring the place-based knowledge required to prevent it (Maliao et al., 2025).

In sum, this dissertation constructs a deliberate, four-part argument, moving from empirical proof of a systemic intellectual injustice (The

Disappearing Effect), to its painful human and ecological cost (The Expert's Grief), to the validation of the knowledge being erased (A Voiceless River), and culminating in a synthesis of total system failure (Crumbling Bank), thereby proving the conservation paradox is a crisis of recognition that demands a radical reorientation of our science. I demonstrate that braiding scientific rigor with the wisdom of place forges a more fair, humane, and effective conservation.

3| Study 1. Conditional visibility: Quantifying the impact of Global North-South dynamics on Philippine aquatic science

3.1 Abstract

This study provides a quantitative model for conditional visibility by revealing the Disappearing Effect: a core mechanism that marginalizes Global South science. Through a scientometric analysis of 132 articles on Philippine aquatic TEK, I show a thematic segregation where international authors target highly-cited topics. This provides the context for the Disappearing Effect where the citation premium for international collaborations vanishes within the national context. This work offers robust, data-driven evidence of center-periphery dynamics, proving that fostering true knowledge equity requires a dual transformation of both global partnership ethics and national academic ecosystems.

3.2 Introduction

Integrating Traditional Ecological Knowledge (TEK) into conservation science is now viewed as essential for tackling urgent environmental challenges (IPBES, 2019; Choquez-Millan et al., 2024; Molnár et al., 2024). Yet, this global push for inclusion confronts a formidable obstacle: the architecture of science remains deeply imbalanced, rooted in a colonial legacy that perpetuates academic dependency (Martins, 2020; Schöpf, 2020). This dynamic often manifests as parachute science, where researchers from highly-resourced nations disproportionately benefit from research in the Global South, undermining the ideal of equitable partnership (Stefanoudis et al., 2021; Dawson et al., 2024). The

consequences are not merely academic. This imbalance directly hinders sustainability by marginalizing the perspectives most crucial for comprehending ecological degradation and phase shifts, particularly the multifaceted TEK of fishing communities (Silvano et al., 2023; Maliao et al., 2025). Consequently, urgent local crises such as a collapsing fishery remain undocumented and unaddressed.

The Philippines provides a compelling microcosm of this global struggle. As an archipelagic biodiversity hotspot (Carpenter & Springer, 2005), the nation possesses rich TEK systems vital for its environmental future (DENR, 2016; Maliao, 2019; Maliao et al., 2025). However, its academic landscape is a "field of struggle" (Alcazaren, 2021), caught between institutional policies demanding publication in high-impact international journals for career advancement (DBM & CHED, 2022) and systemic domestic challenges like funding deficits and research hesitancy (Calma, 2010; Barrot, 2021). This study applies a scientometric lens, a data-driven approach for examining the architecture of a research field, to move beyond anecdotal critique (Van Raan, 2014). By quantitatively mapping this national TEK landscape, I delineate how these interacting global pressures and internal challenges shape scholarly impact and create systems of conditional visibility.

To achieve this, I quantitatively investigate the mechanisms that produce this conditional visibility, using Philippine aquatic TEK as a model system. I test two primary hypotheses in sequence. First, drawing on theories of scientific labor division (Bradley, 2008), I test the hypothesis that internationally-affiliated authors disproportionately focus on topics with higher global citation potential. Then, to determine how this thematic

segregation shapes the citation economy I test my central hypothesis: the widely assumed citation premium from international collaboration is an artifact of the global evaluation system. To verify this, I use a multi-stage factorial analysis to statistically isolate what I term the Disappearing Effect: the disappearance of this premium when the analysis is restricted to the national context.

3.3 Methods

This study presents a targeted analysis of aquatic TEK research, using a corpus of articles extracted from a comprehensive systematic map of Philippine ILK. The entire methodology adheres to the guidelines of the Collaboration for Environmental Evidence (CEE) and the Reporting Standards for Systematic Evidence Syntheses (ROSES, Haddaway et al., 2018); the full protocol is registered (Maliao & Tóthmérész, 2025a, 2025b).

3.3.1 The systematic map: From search to corpus

I conducted a comprehensive literature search of major international bibliographic databases, including the Web of Science Core Collection, Scopus, PubMed, and the Directory of Open Access Journals (DOAJ). This search was then supplemented with key regional sources, such as the ASEAN Citation Index and Philippine E-Journals. My search strategy combined three core concepts using Boolean operators: (A) ILK and its synonyms, (B) environmental stewardship, and (C) the Philippine context. Following deduplication in EndNote (v. 21.5), I screened all records in a two-stage process: first, a title and abstract screening, followed by a full-

text review in Colandr (Cheng et al., 2018) . Eligibility was restricted to peer-reviewed English-language articles that focused on the Philippines (Population), documented aquatic-related TEK (Exposure), and reported primary data (Outcome). This systematic process yielded the final corpus of 132 articles (see Figure 3.1).

For each article, I extracted standard bibliographic data and retrieved citation counts (Google Scholar, May 2025). From this, I calculated a normalized impact metric, Citations Per Year (CPY), using the following formula:

$$CPY = \frac{\text{Total Citations}}{(\text{Year of citation analysis} - \text{Publication Year}) + 1}$$

I then manually coded several indicators of knowledge production. Author attributes included gender (Male/Female) and institutional affiliation (Philippines or International). For domestic authors, I coded their primary study site based on the archipelago's principal geographical divisions: Luzon, Visayas, or Mindanao. Publication attributes included funding status (Funded or Unfunded) and the journal's indexing status (Core for Scopus/WoS, DOAJ, or Local).

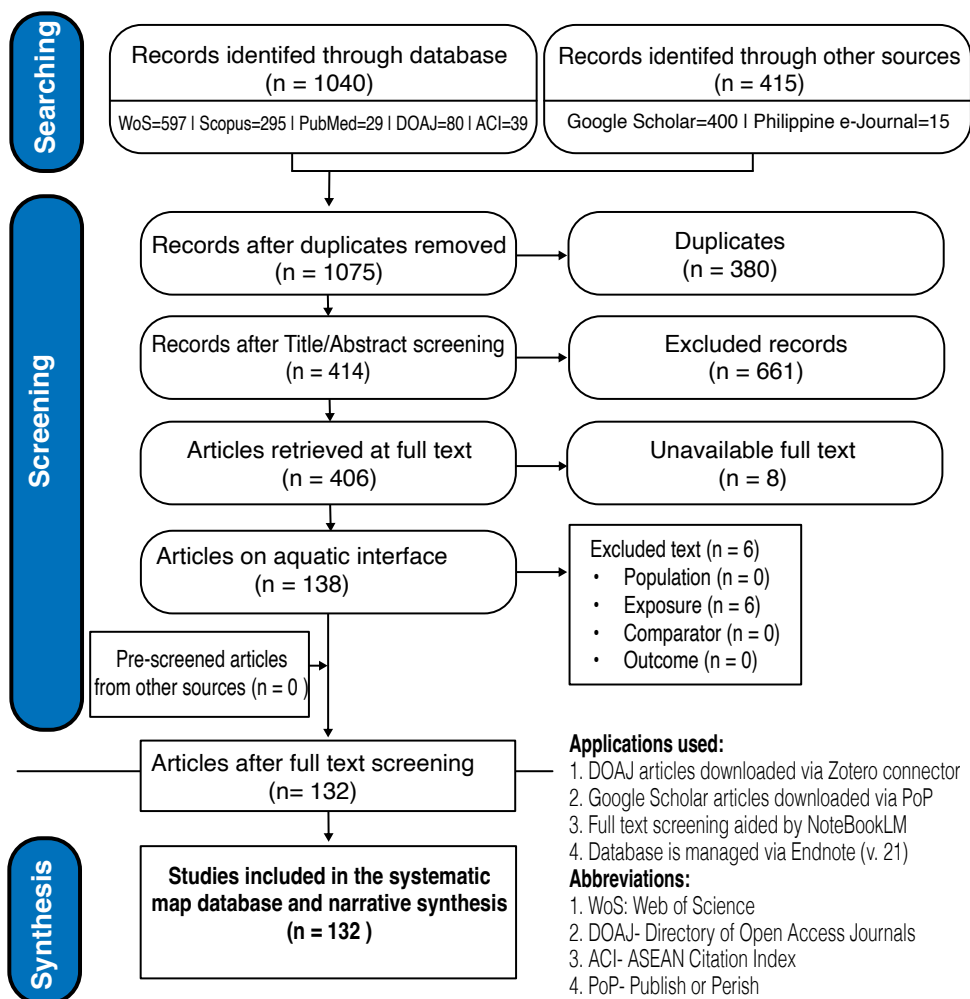


Figure 3.1| Study selection workflow. The diagram illustrates the systematic study screening and selection process, following the ROSES reporting standard, and shows the number of records at each stage, from initial identification to the final included corpus of 132 articles.

3.3.2 *Analytical framework: From themes to interactions*

My analysis proceeded in three stages. First, for the thematic analysis, I generated a keyword co-occurrence network in VOSviewer (v.1.6.20, Van Eck & Waltman, 2010) to identify the primary research clusters. Given the skewed nature of citation data, I report all descriptive statistics for CPY using medians and Interquartile Ranges (IQRs).

Second, I conducted bivariate tests to examine associations between variables. For categorical data, I used the Chi-Square test of independence or Fisher's Exact Test where it was appropriate. For two-group comparisons in CPY (Funding Status, Author Affiliation, and gender), I used the Mann-Whitney U test. For comparing the three Philippine author regions, the Kruskal-Wallis H test was used. Any significant results were followed by Dunn's pairwise tests with Bonferroni correction.

Third, to test my central hypotheses I used a two-part factorial analysis. I first performed a non-parametric Aligned Rank Transform (ART) Analysis of Variance (ANOVA) on the full dataset ($N = 132$) to test the three-way interaction between author gender, affiliation, and funding. Then I conducted a separate three-way ART ANOVA on the subset of articles from Philippines-affiliated authors only ($N = 88$). This two-stage approach was essential for statistically isolating the conditional nature of citation advantages and directly testing for the Disappearing Effect. I analyzed significant interactions using pairwise comparisons with p -values adjusted via Tukey's method. All analyses were performed in R (v. 4.3.2) with a significance level (α) of 0.05.

3.4 Results

The analysis of the 132-article corpus reveals a knowledge landscape dominated by first authors from institutions in Luzon ($N = 59$) and international affiliations ($N = 44$), with a relatively balanced gender distribution. A prominent geographic pattern emerged, indicating that authors predominantly conducted research within their respective major island groups (Figure 3.2).

3.4.1 *The systematic map: Thematic and production landscapes*

A keyword co-occurrence analysis identified three distinct thematic clusters: Applied Conservation and Fisheries Management, Ethnoecology and Aquatic Governance, and Socio-ecological Resilience and Climate Adaptation. These themes show a strong disparity in scholarly impact. The Applied Conservation cluster attracted the highest median Citations Per Year (CPY) of 2.06, while the Ethnoecology cluster received the lowest at 0.80. A temporal analysis indicates that while all themes exhibit growth, publication has accelerated since 2016. Notably, research on freshwater ecosystems is a relatively recent phenomenon, emerging predominantly after 2020 (Figure 3.3).

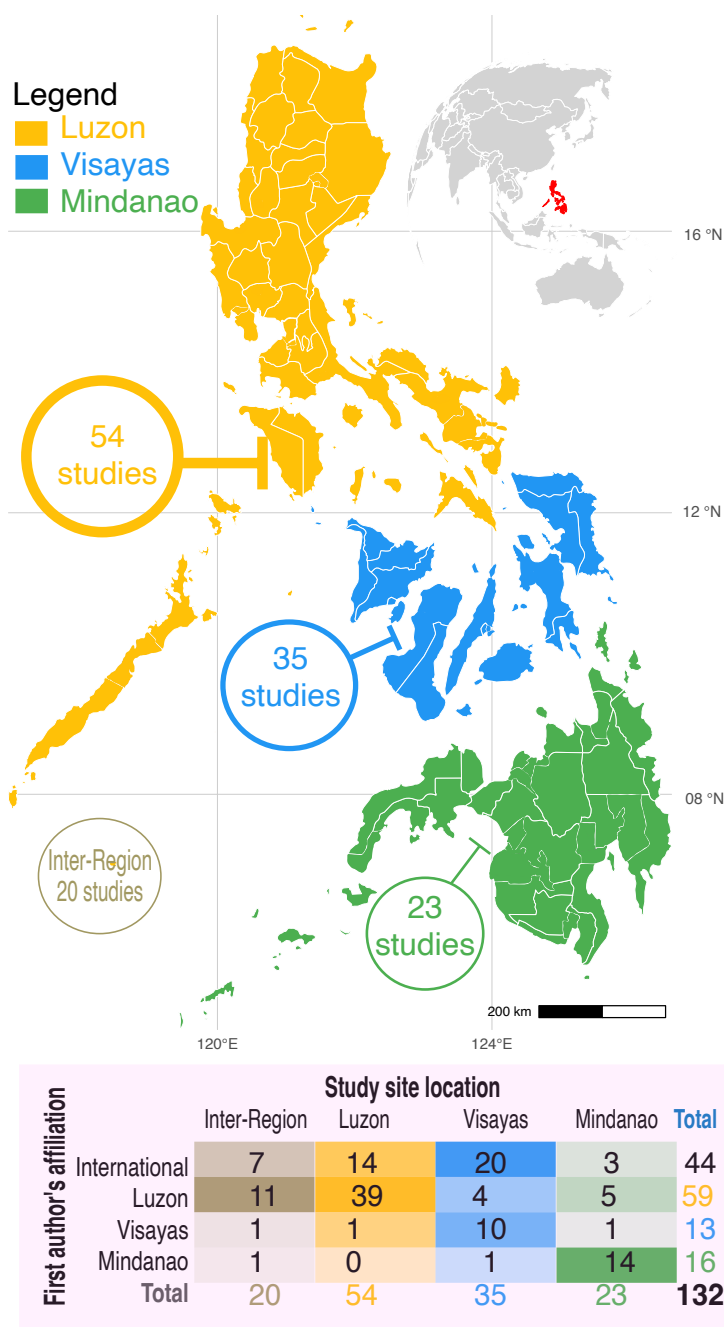


Figure 3.2| Research efforts are highly localized. The geographic distribution of the 132 articles analyzed reveals a strong tendency for intra-regional research. The main map provides geographic context, while the inset heatmap quantifies this pattern, showing the number of studies conducted in each Philippine region (columns) by first authors from that same region (rows).

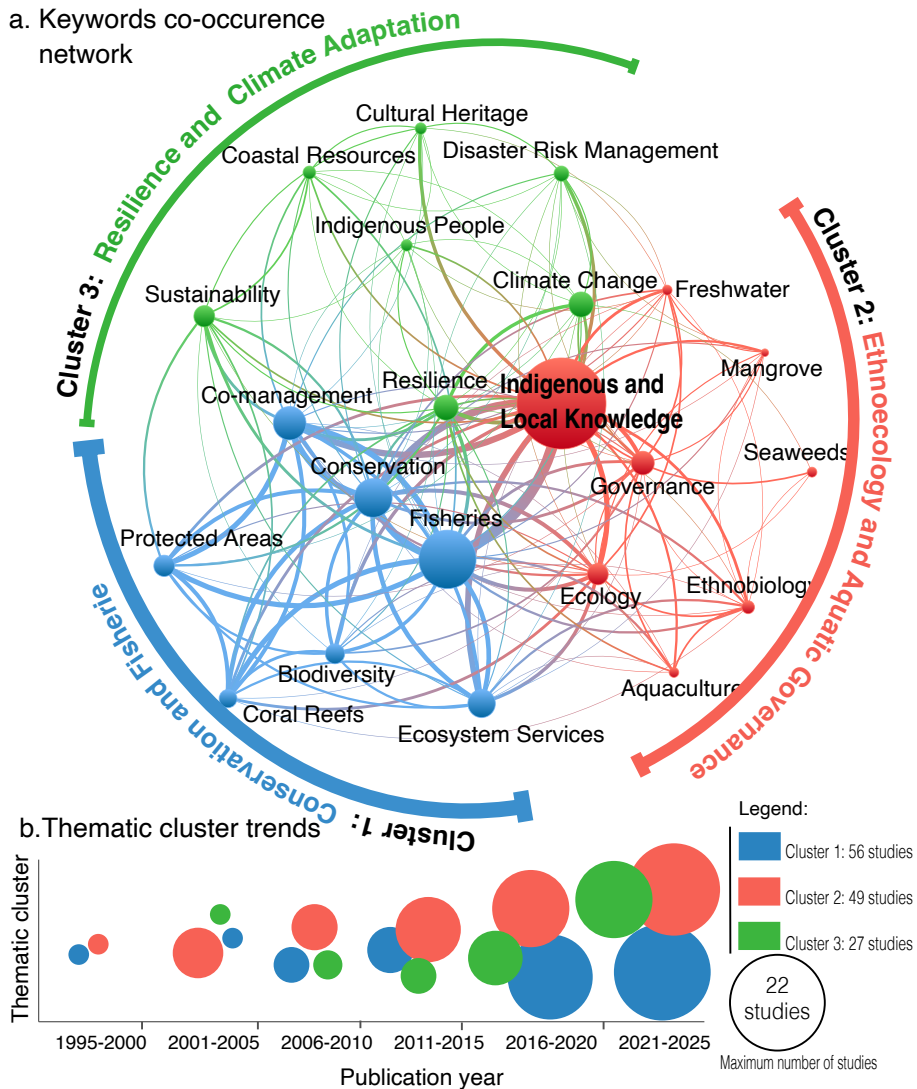


Figure 3.3| Thematic landscape reveals a citation disparity. (a) A keyword co-occurrence network ($N=132$ articles) identifies three distinct thematic clusters. Notably, these clusters have different scholarly impacts, with Applied Conservation (blue) being the most cited and Ethnoecology (red) the least (see Results). (b) Publication frequency across all themes has accelerated since 2016, particularly for the Ethnoecology and 'Resilience' (green) themes.

The knowledge production landscape is primarily domestic, with two-thirds of all studies ($N = 88$) first-authored by researchers from Philippine institutions. The field is also well-funded, with two-thirds of studies ($N = 88$) reporting support. Despite this domestic focus, scholarly impact, measured by cumulative CPY, is overwhelmingly concentrated in ‘Core’ (Scopus/Web of Science) indexed journals, with Philippines-led research contributing a key share of this high-impact scholarship (Figure 3.4).

3.4.2 *Unveiling the Disappearing Effect: A factorial analysis*

Bivariate analyses provided initial insights into the factors shaping the field. Thematic focus was strongly associated with both geography ($\chi^2(9) = 102.81, p < .001$) and author affiliation ($\chi^2(2) = 6.53, p = .038$) with international authors concentrating on the higher-cited ‘Applied Conservation’ theme. Citation impact was clearly linked to funding, with funded studies having a significantly higher median CPY than unfunded ones (Mann-Whitney $U = 2445.5, p = .014$). Within the Philippines, an author’s region also mattered, as studies from the Visayas had a lower median CPY than those from Luzon (Kruskal-Wallis $H(2) = 7.71, p = .021$).

The bivariate tests, however, revealed a puzzling contradiction. I found no significant difference in citation impact between Philippines-affiliated and international-affiliated authors when tested directly ($p = .239$), nor between female- and male-authored papers ($p = .508$). This apparent contradiction, however, was not a flaw in the data; it was the signal of a deeper, interactive dynamic at play.

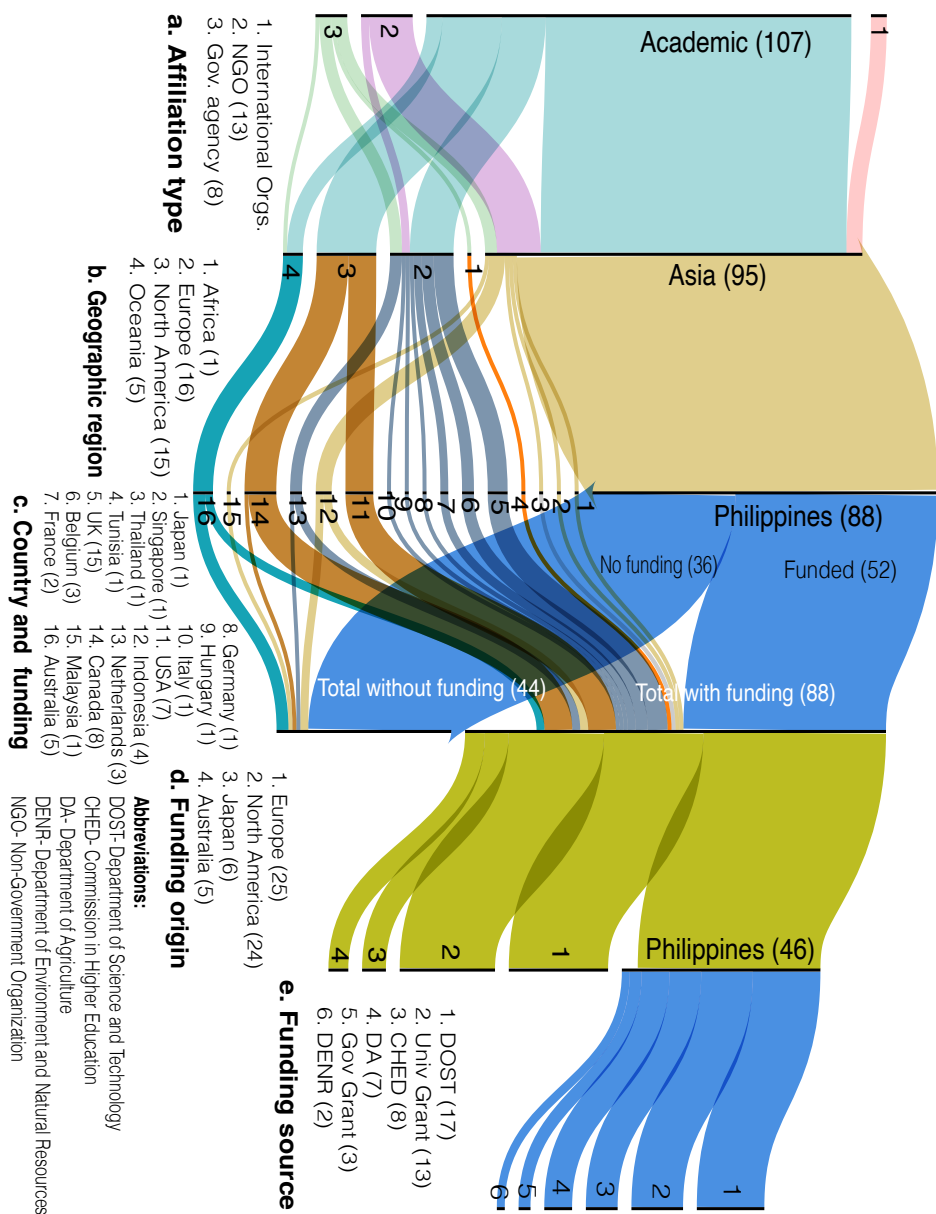


Figure 3.4| The flow of knowledge production. This Sankey diagram visualizes the flow of 132 studies from author origin (left) to funding source (right). The diagram reveals that while domestic academic institutions are the dominant knowledge producers, international sources provide a substantial share of the research funding. The width of the flow is proportional to the number of studies.

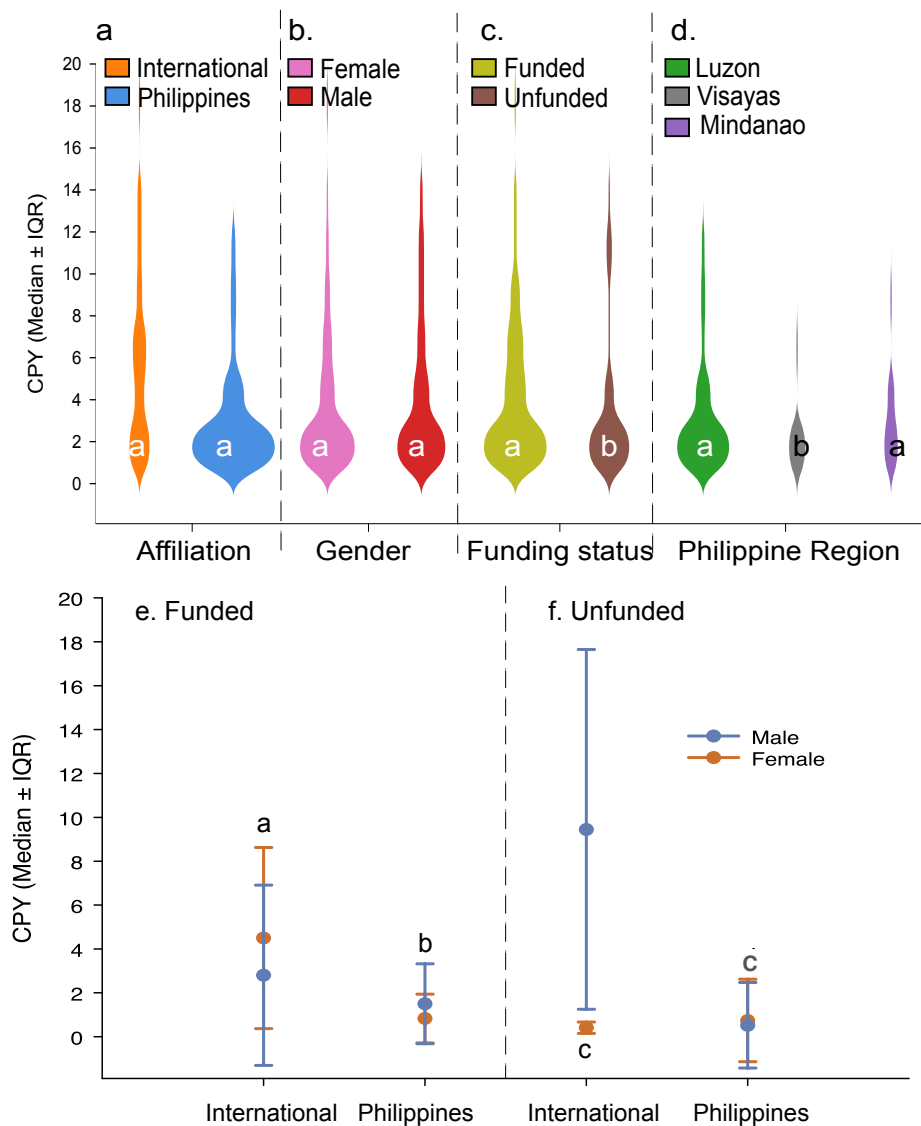


Figure 3.5| The conditional nature of citation advantage and the Disappearing Effect. (a–d) Violin plots showing CPY distributions for key bivariate comparisons. Here, groups not sharing a letter are significantly different ($p < .05$) based on Mann-Whitney U or Kruskal-Wallis tests. e, f, Line plots of the significant three-way interaction ($p < .001$) from the ART ANOVA, which reveals the source of the Disappearing Effect. A citation premium for funded international authors is evident in the global dataset (e), but this advantage is not present in the unfunded condition (f) and vanishes entirely in the Philippines-only dataset.

This final analysis revealed the study's crucial finding. In the first stage of ART ANOVA, an analysis of the full dataset ($N = 132$) showed a highly significant three-way interaction between author's gender, affiliation, and funding ($F(1, 124) = 12.06, p < .001$), which superseded all main effects. Pairwise testing confirmed that this was driven by a clear pattern: funded international authors received a significant citation premium over their funded Philippines-based counterparts ($p = .004$). This premium then vanished in the second stage of the analysis. When I analyzed the Philippines-only subset ($N = 88$) the previously significant three-way interaction disappeared completely ($F(3, 72) = 0.92, p = .433$). This demonstrates the Disappearing Effect: the citation advantage linked to international affiliation and funding is a conditional property of the global research system, not an inherent quality of the research itself (Figure 3.5).

3.5 Discussion

My findings reveal a contradiction in global science: the very structures meant to foster knowledge can also deepen the inequities that render local expertise invisible. The results explain this paradox by first identifying a thematic segregation between international and Philippine-affiliated authors. This segregation, in turn, creates the conditions for the Disappearing Effect, a mechanism where the citation advantages of international affiliation vanish when the national research system is analyzed in isolation. This provides robust, data-driven evidence for how parachute science and enduring center-periphery dynamics forge a system of conditional visibility for Global South scholarship (Schöpf, 2020; Stefanoudis et al., 2021; Miller et al., 2023). This system has profound ecological consequences: when the scientific focus is skewed towards

globally-funded Applied Conservation topics, it can lead to a critical neglect of locally-specific ecological problems and the grassroots knowledge needed to solve them.

This thematic division of labor has profound ecological consequences. My analysis shows that internationally-affiliated authors disproportionately focus on the high-citation theme of Applied Conservation, while Philippine authors concentrate on lower-cited Ethnoecology and Governance. When highly-visible conservation research is decoupled from locally-grounded knowledge on governance, policies risk being ill-informed. The scientific focus often becomes skewed toward globally-funded topics. This leads to the neglect of specific problems only local experts can see, such as the subtle loss of riverine anisopterans, the creep of non-native species into the catch, and the disappearance of culturally vital anurans (see details in the next chapters). This is how biodiversity is lost: not with a bang, but through a gradual but insidious unrecorded contraction. It is precisely this dynamic that fosters well-documented failures like the proliferation of ineffective ‘paper’ Marine Protected Areas (MPAs), a phenomenon seen both in the Philippines and globally (Maliao et al., 2009a, 2009b; Relano & Pauly, 2023).

The Disappearing Effect is the core mechanism driving these disparities, providing a quantitative measure of parachute science in action. The citation premium held by funded, internationally-affiliated researchers vanished entirely within the Philippines-only subset. This is not simply about individual prestige; it is a structural phenomenon consistent with the Matthew effect in science, where recognition accumulates for those

already in positions of privilege (Merton, 1968; Nakamura et al., 2023). This global dynamic is compounded by internal struggles. My finding that internal funding has no significant citation effect suggests that project-level resources are often insufficient to overcome pervasive institutional barriers like heavy teaching loads and bureaucracy, which foster research hesitancy (Durante et al., 2023). This internal struggle, intensified by publish or perish pressures (San Juan, 2024), is a local manifestation of a global knowledge division (Nchinda, 2002; Beigel, 2014). This dynamic even operates at a national scale, as evidenced by the citation disparity between the Visayas region and the capital, a quantitative data point for the Imperial Manila syndrome (Calma, 2010; Barrot, 2021).

3.6 Conclusion

This study provides quantitative evidence that a scientist's visibility is not a simple metric of quality, but a product of the global and national systems in which they work. By demonstrating how a thematic division of labor creates the conditions for a Disappearing Effect, this work reveals that the benefits of Global North-South partnerships are profoundly mediated by the institutional capacity of local research ecosystems. Fostering genuine knowledge equity, therefore, demands a dual transformation: reforming global partnership ethics while simultaneously strengthening national research capacity.

This study therefore offers more than a diagnosis; it provides a replicable, quantitative toolkit to hold conservation science accountable for the ecological crises it fails to see. My framework for quantifying conditional visibility reveals how the global research architecture systematically

obscures the science needed most: the place-based work that tracks the slow collapse of a local fishery or the decline of a culturally vital species. For science policy in the Philippines my results show that enhancing research impact requires confronting these systemic institutional challenges (Alcazaren, 2021; San Juan, 2024). Globally, these findings demand a shift from the simple instrumentalization of local knowledge (Lam et al., 2020) toward models that genuinely empower Indigenous and local communities as equitable partners (Brondízio et al., 2021; da Silva et al., 2025). To achieve this, mandating local co-Principal Investigators and instituting Ethics and Equity Statements (Oztig, 2022; Choquez-Millan et al., 2024) are not just acts of social justice; they are methodological necessities for producing a science capable of solving complex, place-based ecological crises.

Having empirically diagnosed the Disappearing Effect, a structural process that renders local science invisible, the question of its consequences becomes urgent. The next chapter shifts from the problem's architecture to its devastating human toll, providing a quantitative model for the Expert's Grief that emerges when a community silently witnesses the degradation of their ecosystem.

4| Study 2. The Expert's Grief: Intimate ecological knowledge deepens sorrow over ecosystem decline

4.1 Abstract

This study provides the first mechanistic model of solastalgia and a quantitative signature for the social impact of Shifting Baseline Syndrome (SBS), unified by a core conservation paradox I term the Expert's Grief. By treating multi-decade fisher testimony as structured evidence I quantify a dual erosion, revealing a multi-decadal trophic shift in parallel with declining community well-being. I show how intimate ecological knowledge, while boosting catch resilience, also fuels this grief in veteran fishers who remember a healthier past. This work reveals grief as a systemic response to ecosystem degradation, mandating that conservation policy address this profound human toll.

4.2 Introduction

Conservation science has largely undervalued the non-material costs of ecosystem degradation. This psychic toll is best understood through the concepts of solastalgia, the place-based distress of a degraded home environment, and ecological grief, the mourning felt for lost species and landscapes (Albrecht et al., 2007; Cunsolo & Ellis, 2018). These costs are felt most acutely by local experts whose intimate, multi-generational knowledge provides an unshifted baseline of ecosystem health (Brondizio et al., 2021; Silvano et al., 2023). This study argues that quantifying this grief is essential for a more humane and effective conservation.

This gap in understanding is not a simple oversight but a systemic problem rooted in the limitations of the prevailing theories. While Social-Ecological Systems (SES) theory is built on the feedback between nature and humanity (Berkes et al., 2000) its quantitative models often fail to capture these profound non-material costs. Similarly, theories of Common-Pool Resource (CPR) management, while celebrating local governance systems (Ostrom, 2009), often overlook the psychological impacts when those systems fail. A social and political lens reveal how this becomes an issue of epistemic injustice, where the knowledge and suffering of marginalized groups are systematically devalued by research and policy hierarchies (Nyssa et al., 2024). I therefore hypothesized that this systemic decoupling would be reflected in the scientific literature itself, manifesting as a thematic segregation between social and ecological research.

This study directly confronts the consequences of this failed integration. I use a national-scale systematic map to empirically document the social-ecological research divide. To bridge this research divide, my case study treats local testimony as structured data to forge the missing quantitative link. I test three interconnected hypotheses: that a quantifiable dual erosion has occurred, where a multi-decadal trophic collapse in the fishery mirrors a steep decline in community well-being. I then test whether fishing experience moderates the perception of this decline, providing an ecological signature of Shifting Baseline Syndrome (SBS). Finally, I argue that this expert knowledge creates the Expert's Grief, a cruel paradox where the wisdom that fosters a fisher's resilience also deepens their sorrow as a living witness to ecosystem decay.

4.3 Methods

The applied methodology proceeded in two main phases: first, a national-scale systematic map to identify a key research gap, and second, a place-based case study designed to fill that gap.

4.3.1. *The systematic map: Revealing the research schism*

To provide a national-level context, I began with the comprehensive systematic map of Philippine TEK that also formed the basis of Study 1, and its full protocol is registered (Maliao & Tóthmérész, 2025a, 2005b). This map adheres to the rigorous guidelines of the Collaboration for Environmental Evidence (CEE) and the Reporting Standards for Systematic Evidence Syntheses (ROSES). While Study 1 used the metadata from this map for scientometric analysis, here I conduct a deeper thematic dive into the content of the 132 included articles. To test my Knowledge Landscape Hypothesis that a schism exists between social and ecological research, I performed a keyword co-occurrence network analysis using VOSviewer (v.1.6.2). This analysis allow to visualize the thematic architecture of the field and empirically confirm the systemic decoupling of social and ecological inquiry.

4.3.2. *Case study: site and data collection*

Having recognized the research gap, I conducted a case study in the Batan estuary, central Philippines, a site selected for its well-documented history of ecological degradation (Altamirano et al., 2010; Kamiyama et al., 2015; Maliao et al., 2023, Figure 4.1). I engaged holders of intimate, generational knowledge by targeting the lead fisher of each household and

subsequently used a snowball sampling approach to interview 448 participants. This technique was necessary because official registries do not identify individuals based on their ecological expertise. While this expert-focused, predominantly male sample is not representative of the entire community, it was a deliberate choice to specifically test the Expert's Grief hypothesis.

From 2019 to 2020, I conducted 448 individual semi-structured interviews. After obtaining verbal informed consent, I collected demographic information and two forms of retrospective data. First, I elicited decadal catch estimates for key species from the 1960s to the 2020s, using recall aids like local ethnomathematical units and anchoring the timeline with prompts referencing key national events. This TEK-based analysis is a viable method for reconstructing long-term histories in data-poor systems, as TEK accounts are well-established for capturing conservation trends (McClenachan et al., 2024), and our own findings on ecological degradation are consistent with formal scientific assessments in the region (Altamirano et al., 2010; Anticamara & Go, 2016).

Second, respondents provided a decadal happiness score (on a 10-point scale) as an indicator of livelihood satisfaction. To improve the reliability of these scores, I employed a context-anchoring technique, requiring participants to first describe the ecological conditions for a given decade before rating their satisfaction within that recalled context. While not a clinical measure of grief, this happiness metric serves as a reliable proxy for the affective dimension of solastalgia and proved sensitive for tracking community-level distress in the same population during the COVID-19 pandemic (Maliao et al., 2023).

4.3.3. Retrospective data analyses

My case study analysis followed a clear inferential path using a series of Linear Mixed-Effects Models (LMMs). To prepare the ecological data, I first categorized each harvested species into one of five ecological guilds based on their predominant trophic level (Table 4.1). To create a robust ecological metric for this decline, I used the first axis of an NMDS ordination (Bray Curtis similarity), which I then statistically validated as a reliable proxy for fishing down the food web (Pearson's $r = -0.78$, $p < .001$). This approach allows to capture not just a decline in catch, but a change in the entire functional structure of the ecosystem, a much deeper and more significant form of degradation.

I then sequentially tested for a dual erosion in well-being and ecology; investigated the ecological signature of SBS using a relative decade $\times$ fishing experience interaction terms; and explored the Expert's Grief by testing for a similar interaction in the well-being model. To probe the systemic nature of the link between ecological degradation and grief I used both a Pearson's correlation and a Redundancy Analysis (RDA). For all LMMs, time was treated as a continuous linear variable (relative decade), an approach confirmed as most parsimonious by the Akaike Information Criterion (AIC).

Table 4.1| Ecological guild assignments enable analysis of functional shifts in coastal fisheries. Classification of each taxonomic family into one of five ecological guilds based on predominant feeding strategies in a Philippine estuarine context. These assignments facilitate the analysis of functional shifts in the fishery over time.

Order	Family	Trophic Guild
Cardiida	Cardiidae	Benthic invertebrate
Venerida	Cyrenidae	Benthic invertebrate
Cardiida	Psammobiidae	Benthic invertebrate
Venerida	Veneridae	Benthic invertebrate
Myopsida	Loliginidae	Benthic carnivore
Octopoda	Octopodidae	Benthic carnivore
Myliobatiformes	Dasyatidae	Benthic carnivore
Decapoda	Palaemonidae	Benthic invertebrate
Decapoda	Penaeidae	Benthic invertebrate
Decapoda	Portunidae	Benthic invertebrate
Decapoda	Sergestidae	Benthic invertebrate
Anguilliformes	Moringuidae	Generalist piscivore
Carangiformes	Carangidae	Generalist piscivore
Cichliformes	Cichlidae	Herbivore/Detritivore
Clupeiformes	Clupeidae	Planktivore
Clupeiformes	Engraulidae	Planktivore
Elopiiformes	Megalopidae	Generalist piscivore
Gobiiformes	Butidae	Generalist piscivore
Gobiiformes	Gobiidae	Benthic carnivore
Gonorynchiformes	Chanidae	Herbivore/Detritivore
Kurtiformes	Apogonidae	Generalist piscivore
Leiognathiformes	Leiognathidae	Planktivore
Lutjaniformes	Lutjanidae	Generalist piscivore
Mugiliformes	Ambassidae	Planktivore
Mugiliformes	Mugilidae	Herbivore/Detritivore
Mulliformes	Mullidae	Benthic carnivore
Perciformes	Caesionidae	Planktivore
Perciformes	Chaetodontidae	Herbivore/Detritivore
Perciformes	Gerreidae	Benthic carnivore
Perciformes	Haemulidae	Generalist piscivore
Perciformes	Nemipteridae	Benthic carnivore
Perciformes	Polynemidae	Benthic carnivore
Perciformes	Scatophagidae	Herbivore/Detritivore
Perciformes	Serranidae	Generalist piscivore
Perciformes	Terapontidae	Generalist piscivore
Pleuronectiformes	Cynoglossidae	Benthic carnivore
Pleuronectiformes	Paralichthyidae	Benthic carnivore
Pleuronectiformes	Soleidae	Benthic carnivore
Scombriformes	Scombridae	Generalist piscivore
Scombriformes	Sphyraenidae	Generalist piscivore
Siganiformes	Siganidae	Herbivore/Detritivore
Spariformes	Lethrinidae	Benthic carnivore
Syngnathiformes	Callionymidae	Benthic carnivore
Tetraodontiformes	Tetraodontidae	Benthic carnivore

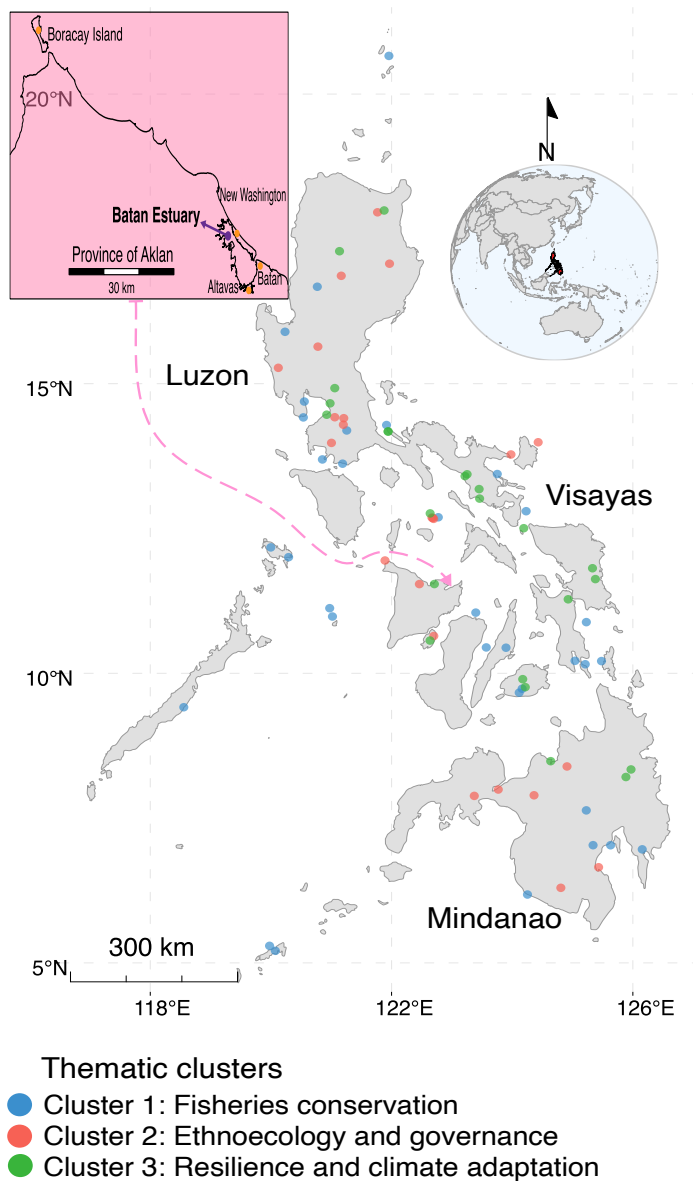


Figure 4.1| The Philippine TEK evidence base is geographically widespread but thematically clustered. Spatial distribution of 132 articles from our systematic review of Traditional Ecological Knowledge (TEK). Each point is a study site, colored by its primary thematic cluster: Applied Conservation and Fisheries Management (blue), Ethnoecology and Aquatic Governance (red), and Socio-ecological Resilience and Climate Adaptation (green). The inset shows the Batan estuary, my case study site.

4.4 Results

4.4.1 *The thematic landscape: A national-scale research schism*

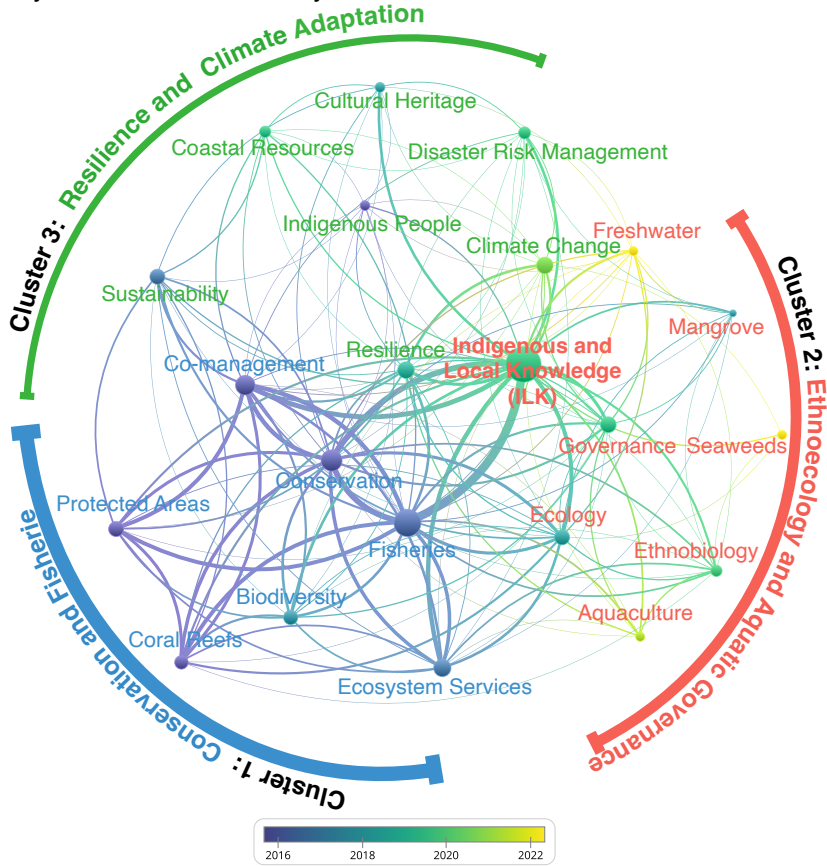
The systematic map of 132 articles confirmed the Knowledge Landscape Hypothesis by revealing a systemic decoupling of social and ecological research within the Philippine aquatic TEK literature (Figure 4.2). The data show that 91% of the literature fails to integrate social and ecological data to test a hypothesis. This decoupling manifests as a thematic segregation of the literature into three distinct domains: Applied Conservation, Ethnoecology, and Socio-ecological Resilience.

Furthermore, internationally-affiliated authors disproportionately focus on the Applied Conservation cluster, while domestic authors concentrate on Ethnoecology (Figure 4.3). This creates a clear research gap in studies that test a directional hypothesis from ecological change to its corresponding impact on human well-being, a divide that my case study was designed to bridge.

4.4.2 *The Batan estuary case study: quantifying the expert's grief*

My case study focused on 448 fishers in the Batan estuary of Aklan, Philippines, a multi-species fishery known for overexploitation. The participants were mostly male (89.8%), with an average age of 48.8 years and 22.3 years of fishing experience. They reported a decline in average daily catch from 3.7 kg in the 1970s to 2.8 kg in the 2020s. This decline coincided with a shift in the fishery's catch composition, from mostly bony fish and crustaceans to including significant targets of cartilaginous fish and cephalopods more recently.

a. Keyword co-occurrence overlay network



b. Thematic cluster trends

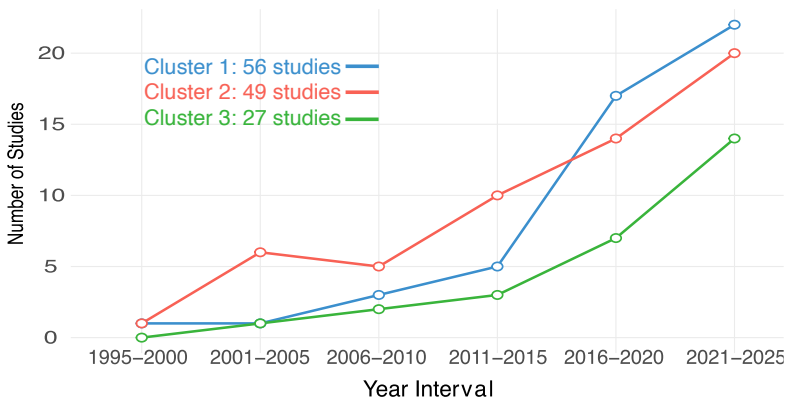


Figure 4.2 | Philippine TEK literature reveals a growing but segregated research landscape. (a) Thematic landscape of 132 research articles, revealing three distinct clusters. (b) Publication frequency (articles per year) for each thematic cluster, showing an acceleration in publications since 2016.

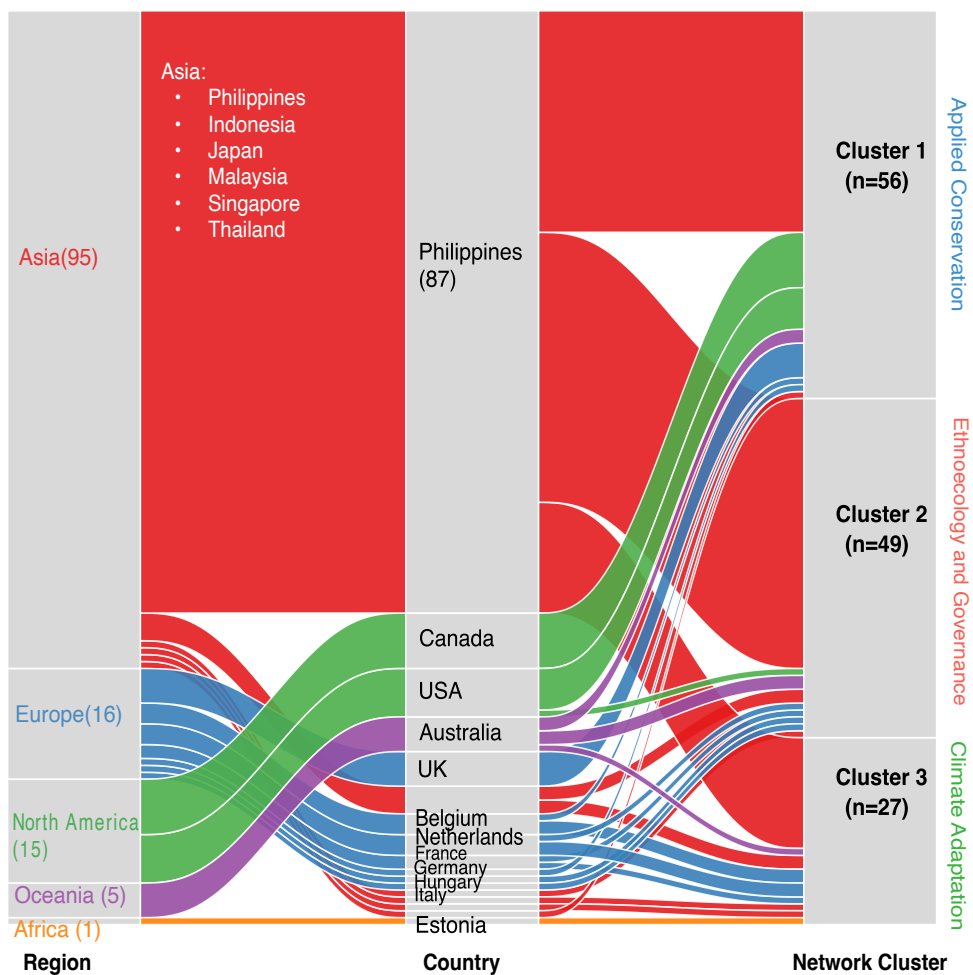


Figure 4.3 | Knowledge production in Philippine TEK research reveals a thematic bias associated with author affiliation. Alluvial diagram illustrating the flow of 132 research articles from the primary author’s continent of origin (left), through their country of affiliation (center), to the article’s primary research theme (right). The width of each flow is proportional to the number of articles.

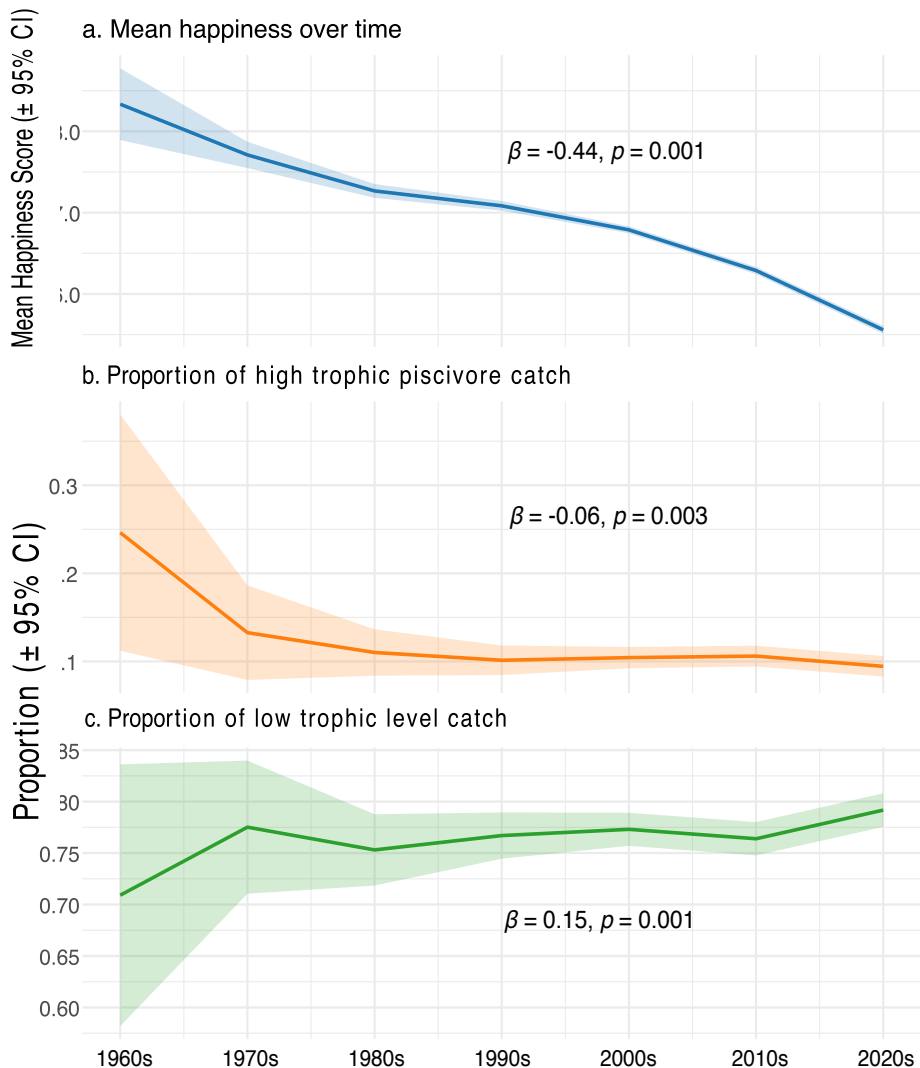


Figure 4.4 | Dual erosion reveals declining fisher well-being and cascading trophic shifts. Decadal trends in socio-ecological indicators from the Batan estuary case study ($N = 448$ fishers). Solid lines represent the mean value per decade; shaded ribbons are the 95% confidence interval. All trends were tested with Linear Mixed-Effects Models (LMMs). (a) Perceived fisher well-being declined significantly ($\beta = -0.44, p < 0.001$). (b) The proportion of high-trophic predators decreased significantly in the catch ($\beta = -0.06, p = 0.003$). (c) The proportion of low-trophic guilds increased significantly in the catch ($\beta = 0.15, p < 0.001$).

My analysis first confirmed a concurrent, decades-long decline in both ecological status and human well-being (Fig. 4.4). The fisher community's perceived well-being dropped significantly over time ($\beta = -0.44, p < .001$) with mean happiness scores falling from a high of 8.3 to 5.6. This social decline occurred in lockstep with a classic ecological collapse: the proportion of high-trophic predators in the catch decreased significantly ($\beta = -0.06, p = .003$) while low-trophic guilds increased ($\beta = 0.15, p < .001$). Collectively, these parallel trends indicate a dual erosion: one line on the graph signifies the depletion of the estuary, while the other represents the waning of hope.

I found that fishing experience significantly moderated the perception of this ecological reality. More experienced fishers reported a slower decline in their high-trophic catch compared to novices (LMM interaction, $\beta = 0.0057, p = .012$, Figure 4.5). This differential perception of the fishery revealed the core paradox. While veteran fishers' knowledge was associated with a more resilient perceived catch, the same group suffered the steepest decline in well-being. A significant negative interaction between decade and fishing experience in the well-being model confirmed this (LMM interaction, $\beta = -0.0012, p = .023$) providing a direct, data-driven signature of the Expert's Grief.

Finally, my analysis revealed that this grief is a diffuse, community-level phenomenon, not a response to individual failure. A Pearson's correlation between the reconstructed happiness and ecological trend slopes for each individual revealed no significant relationship ($r(438) = .03, p = .49$). A complementary Redundancy Analysis (RDA) further revealed that fishing gear is a primary driver of an individual's catch composition, masking

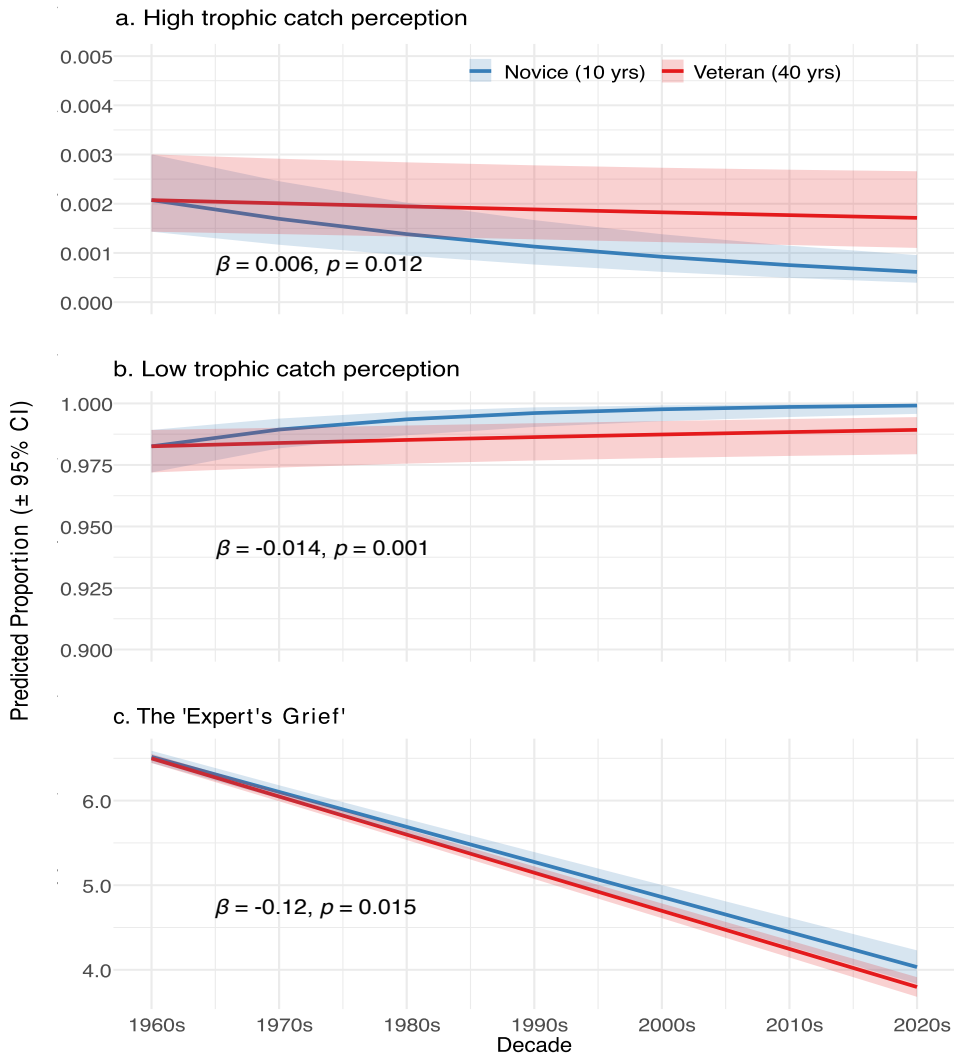


Figure 4.5 | The Expert's Grief paradox: veteran fishers report steeper declines in well-being despite perceiving a more resilient catch. (a–c) The panels show that veteran fishers perceive a slower decline in high-trophic catch (a) and do not perceive the increase in low-trophic catch seen by novices (b), yet they experience a significantly sharper fall in well-being over time (c). All panels show predicted trends from Linear Mixed-Effects Models (LMMs) for a representative Novice (10 years of experience) and Veteran (40 years of experience). Solid lines are predicted means; shaded ribbons represent 95% confidence intervals. The key decade $\times$ experience interaction term was significant in all three models (high-trophic catch, $p = 0.012$; low-trophic catch, $p < 0.001$; well-being, $p = 0.023$).

direct individual-level links ($p < .001$). This decoupling of individual outcomes from collective well-being provides direct evidence that the observed grief is a systemic response to the degradation of a shared ecosystem.

4.5 Discussion

My findings revealed the mechanism behind a core conservation paradox I term the Expert's Grief. This paradox unfolds within the context of Shifting Baseline Syndrome (SBS), the phenomenon where each new generation accepts a degraded ecosystem as normal (Pauly, 1995; Soga & Gaston, 2024). My research provides a quantitative signature for the social process underlying this syndrome by showing that the perception of ecological degradation is patterned by experience. Veteran fishers, with their unshifted, lived-experience baselines, are unique in their ability to perceive the full magnitude of the fishery's trophic shift. This differential ecological perception is the engine of the paradox: the intimate knowledge that builds a veteran's livelihood resilience also becomes the very conduit for their grief, a psychic toll for witnessing the erosion of a system that has defined their lives (Markkula et al., 2024).

The empirical foundation for this paradox is my documentation of a dual erosion: a concurrent, decades-long degradation in both the trophic status of the fishery and the self-reported well-being of the community. The trophic shift is a classic ecological signature of fishing down the food web, a globally recognized pattern of degradation driven by increasing fishing pressure (Pauly et al., 1998). Moreover, my data reveal a deeper functional restructuring through the emergence of cartilaginous fishes and

cephalopods as new targets. This signifies a fundamental loss of ecosystem structure: top-down predatory control vanishes, likely triggering an explosion of opportunistic mid-level species and shifting the entire food web towards a simplified, less resilient state (Gutgesell et al., 2024). This ecological crisis exacerbates the profound social vulnerability of a community where most households already endure extreme poverty (Maliao et al., 2023) situating the local experience in Batan estuary within a global narrative of ecological impoverishment (Cabral et al., 2025).

This paradox was not merely invisible; it was actively obscured by a fundamental schism in how conservation science produces knowledge, which my national-scale systematic map makes tangible. The literature is segregated, with internationally-led Applied Conservation research treating TEK as an instrumental dataset, while domestically-driven Ethnoecology research documents TEK as a holistic worldview with sophisticated governance systems (Biclar et al., 2018; Maliao et al., 2025). This decoupling of the social knowledge from the ecological knowledge is a form of epistemic injustice that creates the methodological blind spot where the human story of grief and its ecological drivers is lost (Nyssa et al., 2024).

By bridging this divide, my findings lend new empirical weight to key theories across disciplines, beginning with ecology itself. The multi-decadal trophic shift I documented provides a powerful, TEK-based validation of a core ecological pattern: fishing down the food web (Pauly et al., 1998). This is not just a local tragedy; it is a classic case of a food web losing its complexity and resilience, potentially pushing the estuary toward a new, degraded stable state. It is the clear ecological signal of a

collapsing system that, in turn, strengthens social and political theories. My work forges the long-sought quantitative link between this measure of trophic decay and community well-being, a central goal of Social-Ecological Systems (SES) theory (Berkes et al., 2000; Estoque & Wu, 2024). It also substantiates a core tenet of social and political ecology by showing how power relations determine whose knowledge of this collapse becomes visible (Robbins, 2019). Critically, my finding of a null correlation between an individual's catch and their well-being refutes methodological individualism, proving the observed grief is a collective response to the degradation of the entire social-ecological system, a classic SES principle of emergent, system-level feedbacks (Ostrom, 2009).

4.6 Conclusion

This study offers a transferable framework to quantify the lived experience of environmental change. Methodologically, I demonstrate that Traditional Ecological Knowledge (TEK) is a sophisticated analytical tool, capable of revealing the nuanced mechanics of a trophic collapse. Politically, I equip managers with a new sentinel indicator (the expert's grief) to track declining social-ecological resilience. Theoretically, I provide robust empirical weight to core tenets of Social-Ecological Systems theory and Political Ecology.

These findings demand clear policy innovation. My framework makes the case for integrating TEK-holders into co-management as legitimate ecological experts. This requires a dual conservation approach focused on healing and foresight: funding community-led programs that turn sorrow

into agency, while deploying integrated monitoring systems that track human well-being alongside the ecological metrics of a recovering food web.

Finally, my case study was designed as a model system to test the theoretical pathway from ecological decay to human grief. The Batan estuary's unique convergence of rapid degradation and deep, multi-generational knowledge provided the ideal conditions to isolate the core mechanisms of the Expert's Grief. My case study yields two generalizable constructs: a mechanistic model of solastalgia and a quantitative signature for the social drivers of Shifting Baseline Syndrome. Together, these provide a new framework for understanding the human consequences of losing a fishery's functional integrity, the cascading collapse of a food web, the shift from top predators to low-trophic generalists, and the simplification of an entire ecosystem. This work proves that by listening to the voices of those who know the water best, we find not just the memory of what was lost, but the empirical proof that human well-being is inseparable from the trophic health and complexity of the worlds we inhabit.

The diagnosis of this dual erosion in both the ecosystem and the community's well-being reveals that the core problem is methodological: a failure to listen. The solution, therefore, must be to validate the scientific power of the very knowledge being ignored.

5| Study 3. A silent river: Charting the socio-ecological toll of freshwater decline through local voices

5.1 Abstract

This study provides a quantitative signature for Shifting Baseline Syndrome (SBS) by revealing a severe, multi-decadal ecological degradation in a data-poor Philippine river. The most powerful indicator of this decline was the drastic reduction of anurans (frogs), a key species local communities use to gauge river health. By operationalizing Traditional Ecological Knowledge (TEK) from 126 fishers, I reconstructed historical data showing current fishery yields are only 28% of 1960s levels. This biodiversity loss is directly linked to declining community well-being, validating TEK as a rigorous methodology for giving a statistical voice to a silenced ecosystem.

5.2 Introduction

Freshwater ecosystems are among the most imperiled on the planet, with vertebrate populations having declined by a staggering 83% since 1970 (WWF, 2022; Sayer et al., 2025). This crisis is exacerbated by a pervasive lack of baseline data, particularly in the megadiverse tropics, which hinders effective conservation (Maasri et al., 2022; Dudgeon & Strayer, 2025). Compounding this data scarcity is the phenomenon of Shifting Baseline Syndrome (SBS), where each new generation accepts a progressively degraded ecosystem as normal, obscuring the true scale of long-term ecological change (Pauly, 1995; Soga & Gaston, 2024). This generational amnesia presents a fundamental challenge, as we cannot hope to restore what we have forgotten. This reveals a central paradox of

modern conservation. The most detailed multi-decadal data on the world's fastest-collapsing ecosystems exists not in formal archives, but in the memories of local experts, a living database that is systematically ignored.

To counter this data gap and societal amnesia, the global conservation community is increasingly turning to Traditional Ecological Knowledge (TEK): the cumulative body of knowledge, practices, and beliefs held by local communities about their environment (Berkes et al., 2000; Molnár & Babai, 2021). As scholars like Johannes (1998) argued decades ago, in "data-less management" situations, TEK is not merely an alternative, but an imperative. This is especially true in the Philippines, a global biodiversity hotspot where freshwater ecosystems are severely understudied (Magbanua et al., 2023; Maliao et al., 2025). While TEK's value for revealing ecological trends has been well-demonstrated in the nation's coastal fisheries (e.g., Muallil et al., 2014; Lavides et al., 2016; Maliao, 2019), its application to freshwater systems, where so much unrecorded biodiversity loss is occurring, remains largely overlooked.

This study's primary goal is to validate Traditional Ecological Knowledge (TEK) as a quantitative tool capable of overcoming the challenges of data scarcity and Shifting Baseline Syndrome. To achieve this, I test whether the social-ecological mechanisms previously identified in an estuarine context hold true in the critically understudied freshwater realm. By operationalizing TEK to reconstruct the multi-decadal ecological history of a data-poor Philippine river, I test three interconnected hypotheses grounded in social-ecological theory (Pauly, 1995; Berkes et al., 2000; Ostrom, 2009). First, I test the primary ecological hypothesis that this

freshwater fishery has also experienced a statistically significant, multi-decadal decline. Second, I test the social-cognitive hypothesis that perceptions of this degradation will vary across age groups, providing a quantitative signature for Shifting Baseline Syndrome. Finally, I test the core social-ecological hypothesis that this ecological degradation is directly coupled with a decline in community well-being.

5.3 Methods

5.3.1 Study site and data collection

This study was conducted in the artisanal fishing community of Nabaoy River, located on the northwestern tip of Panay Island, Central Philippines. The 17-kilometer long Nabaoy River, which flows through the community, is an integral part of the North-West Panay Peninsula Natural Park (Figure 5.1).

I employed a participatory, decolonized research approach. I selected participants using a purposive sampling strategy, targeting residents with at least 10 years of residency and continuous engagement in fishing. Of the community's 300 households, 126 (42%) met these criteria. From each participating household, I randomly selected one male and one female respondent for interviews to ensure gender balance, following the ethical guidelines of Bunce et al. (2000). Employing well-trained local residents as interviewers fostered trust and led to richer data.

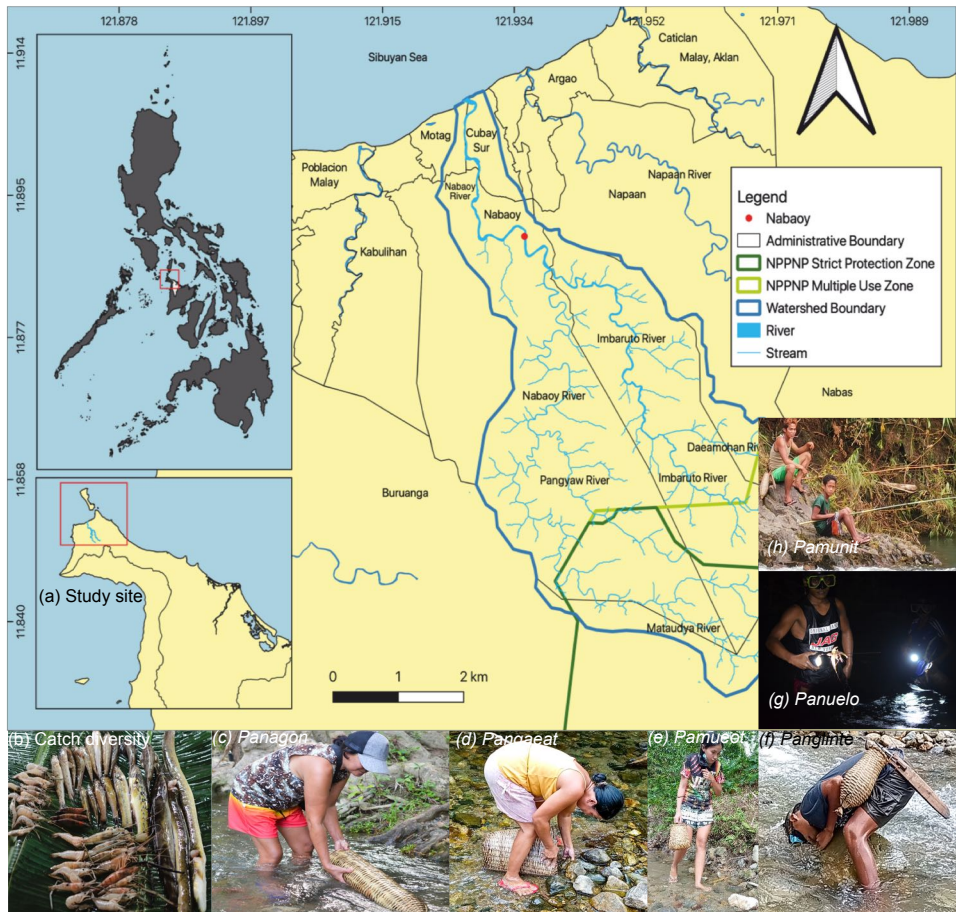


Figure 5.1| The Nabaoy River social ecological system and its traditional fishery. The study was conducted in the Nabaoy River, located within the North-West Panay Peninsula Natural Park in Aklan, Philippines (a). The local artisanal fishery harvests a diverse array of aquatic fauna (b) using a suite of traditional, subsistence-oriented methods. These include trapping with locally-crafted *taun* (c, *panagon*), the use of handheld traps (d, *pangaeat*), gleaning for less mobile species like gastropods (e, *pamueot*), both day and nighttime spearfishing (f, *panglente*; g, *panuelo*), and pole-and-line fishing with locally-sourced materials (h, *pamunit*).

The core of my data collection, conducted from July to December 2021, involved semi-structured interviews. To validate local ethnotaxonomy, I first co-created a photographic database of local fauna with expert fishers. During the interviews, I collected retrospective catch data (in kilograms per species) from the 1960s to 2021. To aid recall, I utilized local ethnomathematical knowledge, such as the "*gantang*" (a container equivalent to ~2.25 kg), and anchored the timeline with prompts referencing key national events (Lavides et al., 2016). To assess well-being, respondents provided a decadal happiness score on a 10-point Likert scale, an approach adapted from Maliao et al. (2023). To validate these interview data, I conducted three Focus Group Discussions (FGDs) with community-identified experts, which confirmed a high degree of consensus.

5.3.2 *Statistical analyses*

I first aggregated the retrospective catch data into six major taxonomic groups (fishes, gastropods, anurans, and three crustacean groups), with subsequent analyses focusing on the 15 most commonly reported finfish families (Teleostei). I then extracted regression coefficients (slopes) from each respondent's multi-decadal catch data using ordinary least squares (OLS) regression.

I then analyzed these slope coefficients using univariate general linear models (GLMs), a robust statistical approach that allowed me to compare the relative vulnerability of different taxonomic groups to the overall ecological decline and to examine the effects of gender and age. Significant main effects were followed by pairwise comparisons using

Bonferroni-corrected estimated marginal means. For the analysis of the 15 finfish families, where variances were unequal, I used Tamhane's T2 pairwise tests. Finally, to directly compare the perceived rates of decline, I used independent t-tests to compare the slope coefficients between gender and age groups. All statistical analyses were performed using IBM SPSS Statistics for Macintosh (version 29), with a significance level of $p < 0.05$.

5.4 Results

5.4.1 The community and its knowledge

My research captured the Traditional Ecological Knowledge (TEK) of 126 fishers along the Nabaoy River, with a near-equal gender distribution (49% male, 51% female) and a wide age range (18-83 years) that ensured representation of both elders and younger members. Participants possessed deep local and historical knowledge, with an average residency of 42 years and 26 years of fishing experience. This TEK is richly expressed through a diverse array of predominantly subsistence-oriented fishing practices passed down through generations. These methods range from fish trapping (*panagon*) using traps crafted from local materials, to barehand fishing (*panikop*), to gleaning for snails (*pamueot*), to day and nighttime spearfishing (*panglinte* and *panuelo*). Prized species like freshwater eels (*Anguilla* spp.) and snakehead murrel (*Channa striata*) are caught using pole and line (*pamunit*), with bait and equipment sourced directly from the local environment (Figure 5.1).

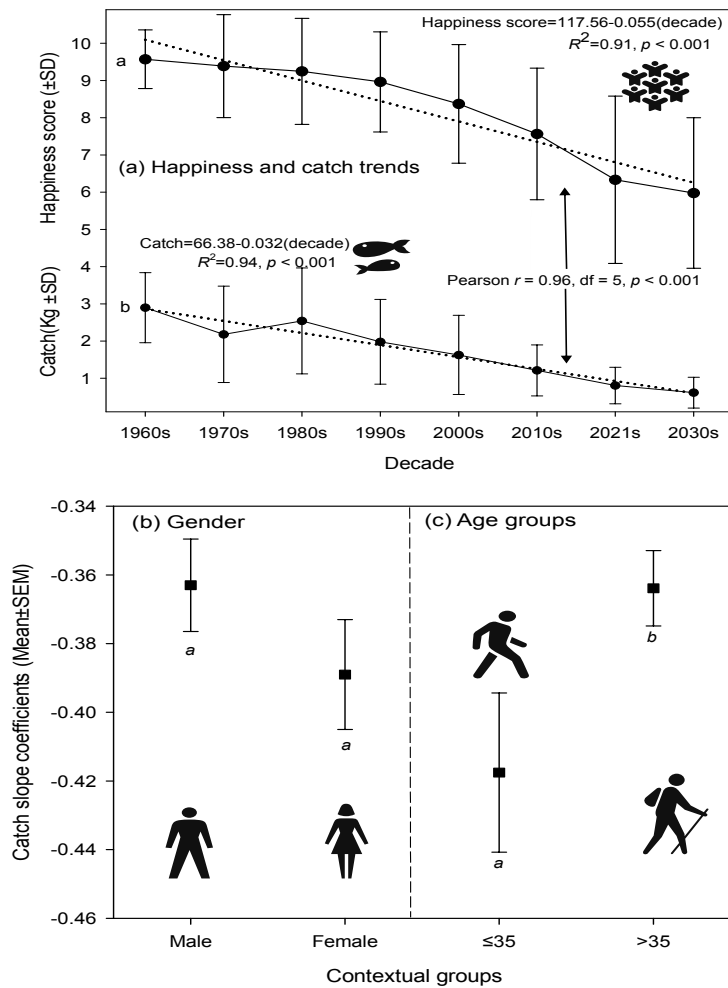


Figure 5.2 | Parallel declines in ecological and social well-being reveal a shifting baseline. Retrospective data from 126 fishers show a significant, multi-decadal decline in both the mean aggregated catch (kg) and the community's self-reported happiness from the 1960s to the 2020s. (a) Analysis of the perceived rates of catch decline revealed no significant difference between male and female respondents. (b) However, a significant difference emerged between age groups, with younger fishers (≤ 35 years) perceiving a steeper rate of decline than their older counterparts (> 35 years) (c), providing a quantitative signature for Shifting Baseline Syndrome. Lines in (a) represent linear regressions; different letters in (c) denote significant differences ($p < 0.05$) from an independent t -test.

5.4.2 *A dual decline in catch and well-being*

The community harvests a diverse array of fauna, including finfishes, gastropods, crustaceans, and amphibians, notably the forked-tongued anuran *Limnonectes* spp. My analysis of retrospective catch data revealed a significant, multi-decadal decline in the aggregated catch from the 1960s to the 2020s ($R^2 = 0.94$, $p < 0.001$). The data show that current yields (mean = 0.80 kg) represent only 28% of the historical catches reported in the 1960s (mean = 2.90 kg). In parallel with this ecological degradation, the subjective happiness scores of the fishing community showed a significant and similarly steep downward trend over the same period ($R^2 = 0.91$, $p < 0.001$, Figure 5.2).

5.4.3 *The signatures of change: Shifting baselines and taxonomic loss*

A more detailed analysis using a univariate General Linear Model (GLM) revealed significant differences in the rates of decline among taxonomic groups ($p < 0.001$). Pairwise comparisons indicated that *Limnonectes* frogs exhibited the steepest decline (mean slope = -0.92), a rate significantly greater than all other groups. This finding is a powerful demonstration of TEK's sensitivity, proving its ability to detect population trends at a fine taxonomic resolution that would be missed by all but the most intensive formal surveys. This analysis also provided a quantitative signature for Shifting Baseline Syndrome. Age was a significant predictor of perceived decline ($p < 0.05$), with an independent t -test confirming that younger respondents (≤ 35 years) perceived a more drastic rate of decline than older respondents (> 35 years) ($t_{1308} = -2.34$, $p < 0.001$, Figure 5.2). This reverse signature doesn't disprove SBS, but rather points to a more

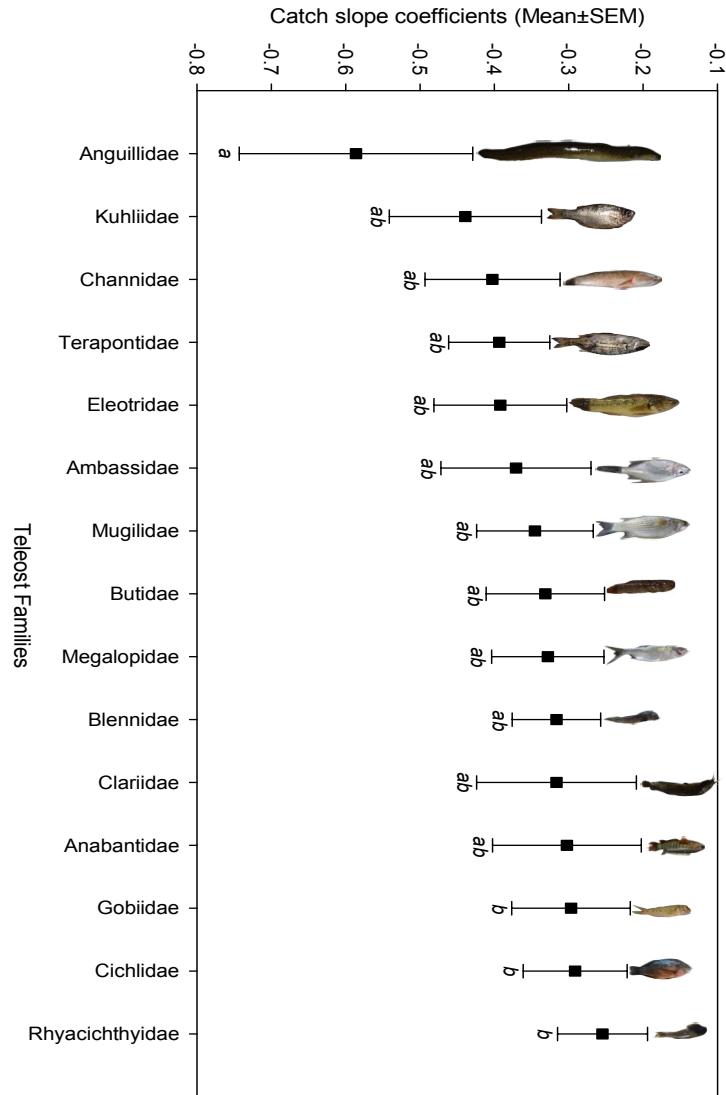


Figure 5.3 | TEK reveals differential decline rates among aquatic taxa. An analysis of the perceived rates of catch decline shows significant differences among the six major taxonomic groups, with anurans (*Limnonectes spp.*) exhibiting the most drastic decline. A more detailed analysis of the 15 Teleostei finfish families reveals that Anguillidae (eels) have suffered the steepest population reduction. This demonstrates that Traditional Ecological Knowledge is sensitive enough to detect not just an overall fishery decline, but also the nuanced, differential impacts across various parts of the ecosystem. Different letters denote significant differences ($p < 0.05$) among groups.

perverse version: the ecological collapse has accelerated so dramatically in recent years that it's now clearly visible even over a shorter time horizon.

Further analysis of the 15 finfish families also revealed significant differences in their rates of decline ($p < 0.001$). A pairwise test identified that Anguillidae (eels) exhibited the steepest decline (mean slope = -0.58), while families like Gobiidae showed the least decline. This demonstrates that the overall decline of the fishery is a complex process with distinct impacts across different parts of the ecosystem (Figure 5.3). This fine-grained analysis demonstrates that the overall fishery collapse is not a monolithic event, but a complex ecological cascade with distinct impacts on different niches.

5.5 Discussion

This study reveals a severe, multi-decadal ecological collapse in a data-poor Philippine river, a history that was only made visible by operationalizing Traditional Ecological Knowledge (TEK) as a quantitative tool. My findings show that current fishery catches represent a mere 28% of their 1960s baseline, a drastic reduction that provides a local, data-driven testament to the global freshwater biodiversity crisis (WWF, 2022; Dudgeon & Strayer, 2025). Together with this ecological deterioration, my analysis revealed a significant decrease in the community's self-reported well-being, underscoring the profound, direct link between ecosystem health and the quality of life for the subsistence-dependent people who rely on it (Maliao et al., 2025).

The ecological details of this contraction, as recalled by local experts, are stark. The most drastic population reduction was observed in an endemic forked-tongued anurans (*Limnonectes visayanus*). This is a critical ecological finding, as it validates the community's use of frogs as key bioindicators of river health and aligns with global assessments of the amphibian crisis (Maliao et al., 2025; Sayer et al., 2025). Their value as bioindicators stems from their biology: their permeable skin makes them highly vulnerable to waterborne pollutants, and their biphasic lifecycle exposes them to stressors in both aquatic and terrestrial habitats (Awkerman et al., 2024). As crucial mid-trophic level predators and prey, their precipitous decline thus signals a potential unraveling of the entire riverine food web. Commercially significant finfish families like Anguillidae (eels) also exhibited significant decreases, which local fishers attribute to a cascade of anthropogenic pressures, including degraded water quality and overharvesting.

My research also provides clear, quantitative evidence for Shifting Baseline Syndrome (SBS) in this community (Pauly, 1995; Soga & Gaston, 2024), but with a troubling twist. Contrary to the classic model of generational amnesia where younger people normalize a degraded state (Papworth et al., 2009), my data show that younger fishers perceive a *steeper* rate of recent decline than their elders. This reverse signature does not disprove SBS; rather, it suggests a more acute modern version. The ecological collapse has likely accelerated so dramatically that its signal is now clearly visible even over a shorter time horizon, creating a new wave of awareness born from rapid loss. This phenomenon is a dual tragedy: it confirms the river's precipitous decay while also threatening the

intergenerational transmission of deep, historical TEK (Molnár & Babai, 2021; Fernández-Llamazares et al., 2023). As biodiversity vanishes, so too does the intricate knowledge system associated with it, creating a vicious cycle that lowers our collective expectations for ecosystem health and undermines future conservation potential.

5.5 Conclusion

This study validates Traditional Ecological Knowledge (TEK) as a robust ecological methodology for uncovering the historical trajectory of a data-poor fishery. My research makes three critical contributions: first, I provide compelling, quantitative evidence of Shifting Baseline Syndrome in a freshwater ecosystem; second, I demonstrates a strong link between a fishery's decline and diminished community well-being; and third, I build a robust case for the central role of TEK in biodiversity assessment.

Ultimately, these findings demand a fundamental shift towards a decolonized, holistic conservation paradigm where local knowledge holders are treated as active partners in all stages of research and co-management (Molnár & Babai, 2021). For the Philippines, this means establishing national biodiversity monitoring that uses TEK to identify local bioindicators, investing in community-based conservation, and mitigating threats through sustainable aquaculture and invasive species control. Embracing this collaborative approach, however, does more than safeguard cultural heritage; it unlocks a powerful scientific tool. This study proves that Traditional Ecological Knowledge (TEK) is not an alternative to data. When applied within a decolonized and locally

resonant framework, it is the data, a high-resolution methodology capable of giving a statistical voice to the world's silent, disappearing rivers.

Having demonstrated that TEK is a robust methodology for quantifying ecological decline, the final step is to apply this lens to the ultimate challenge: building a holistic and resilient conservation strategy. This final study therefore serves as a grand synthesis, integrating TEK on climate impacts, fisheries, and traditional taboos to reveal a complete social-ecological system in crisis.

6| Study 4. Mending fractured waters: Braiding Traditional Knowledge with science to heal Philippine ecosystems

6.1 Abstract

This study reveals how Traditional Ecological Knowledge (TEK) and local taboos create a sophisticated, informal governance system for freshwater conservation. In a data-poor Philippine river, I show that fishers use key bioindicators, like frogs and dragonflies to track the ecological impacts of climate change. Crucially, their traditional fishing taboos mirror and reinforce formal conservation measures, demonstrating a pre-existing, culturally-embedded management framework. These findings prove that effective conservation requires integrating this place-based TEK and its informal institutions, treating local communities as essential partners in building resilient social-ecological systems.

6.2 Introduction

Freshwater ecosystems worldwide are imperiled by multifaceted threats such as overexploitation and pollution, and magnified by the pervasive impacts of climate change (Reid et al., 2019; Tickner et al., 2020; Su et al., 2021). This crisis is particularly acute in the global biodiversity hotspots of Southeast Asia, yet these vital ecosystems receive far less attention than their terrestrial or marine counterparts (Tydecks et al., 2018; Coleman et al., 2019). The Philippines, a nation ranked among the most vulnerable to extreme weather events (Eckstein et al., 2018), exemplifies this challenge. With hundreds of its rivers considered biologically dead or severely polluted (Pineda-Ofreneo, 2019;

Bengwayan, 2019) and a perennial lack of government resources for monitoring, freshwater conservation in the Philippines often hinges on local, community-driven initiatives (van der Ploeg et al., 2017). This final study is therefore situated at the convergence of the preceding chapters, serving as a synthetic case study of how the structural inequities I exposed (Study 1), the human costs I quantified (Study 2), and the methodological power of the knowledge I validated (Study 3) manifest in a single social-ecological system.

To address this data and governance gap, conservation is increasingly turning to the integration of Traditional Ecological Knowledge (TEK), the cumulative body of knowledge, practices, and beliefs held by local communities about their environment (Berkes et al., 2000; MacPhail & Colla, 2020). TEK is now recognized by global bodies like IPBES as an essential knowledge system for understanding environmental change and fostering resilience, particularly in data-poor contexts (Johannes, 1998; Aswani et al., 2018). This knowledge is also a form of social capital; the local norms and beliefs in which it is embedded facilitate the collective action essential for sustainability (Putnam, 2000; Pretty & Smith, 2004). In the Philippines, TEK has proven vital in numerous contexts, from forest management to fisheries monitoring (Maliao, 2019; Landicho et al., 2021).

This study investigates how the TEK of a local fishing community can strengthen freshwater conservation in the face of climate change. Using a case study approach in a data-poor Philippine river, I test three primary, interconnected hypotheses. First, that local communities possess a sophisticated awareness of climate change, which they link directly to the

decline of key ecological indicator species. Second, that fishers' TEK can reveal significant, multi-decadal changes in the fishery that are otherwise undocumented. Finally, I test the hypothesis that traditional fishing-related taboos function as a critical form of social capital (Putnam, 2000), representing a set of socially-shared rules that create an effective, informal conservation system (Colding & Folke, 2001). By testing these hypotheses, this study serves as the final, synthetic case study, demonstrating how the structural, social, and methodological issues explored in the preceding chapters converge to impact a single social-ecological system.

6.3 Methods

This study is a direct continuation of the fieldwork presented in Study 3, using the same cohort of participants and dataset to answer a distinct set of questions related to climate change.

6.3.1 Study site and sampling method

My study was conducted in the village of Nabaoy, a riverine fishing community straddling the 17-kilometer Nabaoy River in Malay, Aklan, Central Philippines. The river, which is the primary source of potable water for the region, is part of the expansive Northwest Panay Peninsula Natural Park (see Figure 5.1).

I followed a mixed-method research approach, beginning with obtaining research permits and conducting community dialogues to present the project's goals. I used a homogeneous purposive sampling strategy, targeting households with at least 10 years of residency and continuous

engagement in fishing. Of the 369 total households, 126 met these criteria, and I sampled this entire population. To ensure gender balance, I randomly interviewed one male or female representative (≥ 18 years old) from each of the 126 fishing households after soliciting their prior consent.

Using a pretested semi-structured instrument, I collected data on three thematic issues: climate change awareness, fisheries knowledge, and fishing-related taboos. This interview data was then triangulated and enriched through three Focus Group Discussions (FGDs) with community-identified expert fishers. All fieldwork was conducted from July to December 2021, and the final results were disseminated to community leaders in 2022 (see published book at <https://ins-poas.nlp.gov.ph/node/206>).

6.3.2 *Data analyses*

My data analysis proceeded in four distinct stages. First, to gauge the community's perception of the primary external pressure, I analyzed climate change (CC) awareness. I used the Chi-Square test to determine associations between awareness and key demographic variables and verified perceived CC manifestations against empirical meteorological data using linear regressions.

Second, to document the ecological impacts of this pressure, I analyzed the perceived decadal catch of river prawns (*Macrobrachium spp.*), the site's most commercially valuable species. I analyzed the overall catch trend using linear regression and then compared inter-decadal differences

using a Friedman Test. Third, to analyze the perceived influence of different CC impacts, such as drier dry months and frequent flooding, respondents rated each on a 10-point scale, which I then compared between sexes using the Chi-Square test.

Finally, to understand the community's internal governance response, I documented and categorized the fishing-related taboos observed by the community, analyzing them as a form of informal, TEK-based resource management. All statistical analyses were performed with a significance level of $p < 0.05$.

6.4 Results

6.4.1 Community profile and climate change knowledge

My research engaged 126 fishing households in Nabaoy, representing a community with deep, multi-generational environmental knowledge. Respondents had an average of 42 years of residency and 26 years of fishing experience. While most households engaged in a mix of subsistence activities, from farming to gathering forest products, river fishing remained a primary or supplemental source of income for all of them (see Figure 6.1). This deep connection to the environment informs the community's sophisticated understanding of climate change (CC). The vast majority of respondents (98%) perceived that the climate was changing, observations consistent with empirical regional meteorological data, which show significantly increasing average and maximum temperatures since the 1910s ($p < 0.001$, Figure 6.2).



Figure 6.1 | Traditional Ecological Knowledge expressed through diverse fishing methods in the Nabaoy River. The local artisanal fishery harvests a diverse array of aquatic fauna, a sample of which is shown (a). Fishers employ a suite of traditional methods, including trapping with locally-crafted *taun* (b, *panagon*); using handheld bait traps with substrate disturbance (c, *pangaeat*); gleaning for less mobile species, a practice common among women and children (d, *pamueot*); daytime spearfishing (e, *panglinte*); nighttime spearfishing with torches (f, *panuelo*); and pole-and-line fishing (g, *pamunit*).

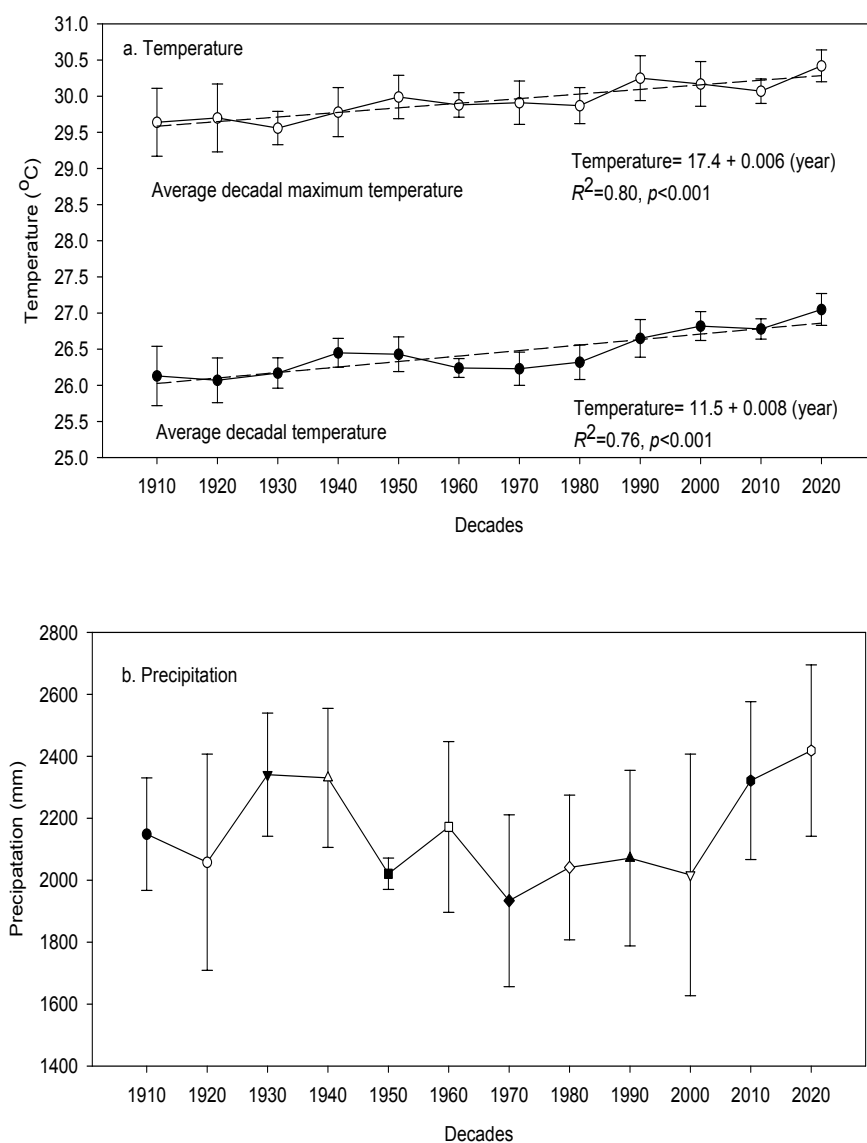


Figure 6.2 | Local knowledge of climate change aligns with empirical meteorological trends. The community's perception of a warming and changing climate is consistent with regional meteorological data from the World Bank's Climate Change Knowledge Portal. The figure shows rising average decadal temperatures (a) and changes in decadal precipitation (b) for the Western Visayas region of the Philippines. Dashed lines represent linear regression trends; error bars are standard deviation.

The community primarily attributed these changes to human activities like deforestation. While awareness of CC was not associated with sex or age, it was positively associated with education level ($p = 0.008$). Overall, residents perceived that CC was causing a cascade of local problems, from extreme dry months and potable water shortages to heavier rains, extreme flooding, and an overall degradation in the fishery (Figure 6.3). These views did not vary by sex, age group, or education.

6.4.2 TEK reveals a collapsing fishery and a hidden governance system

The local riverine fishery is a multi-species, multi-gear, and primarily subsistence system, with harvesting strategies passed down through generations. My analysis focused on the aggregated perceived catch of river prawns (*Macrobrachium spp.*), the most commercially valuable species, which local taxonomy divides into six distinct types (Figure 6.4). The results show a significant and drastic depletion in the prawn fishery, with linear regression analysis indicating a 10% decline per decade since the 1960s ($R^2=0.92$, $p < 0.001$). The harvest reported in 2021 was approximately 0.4 kg per individual per fishing trip, representing only 24% of the perceived catch in the 1960s (Figure 6.5).

My research documented fishing-related norms and taboos rooted in mythical spirits, serving as an informal management system (Table 6.1). These taboos, like formal fisheries management restrictions, often mirror temporal and spatial restrictions. This shows the community has a rich TEK about the fishery and a pre-existing, culturally-embedded governance structure for its conservation (Table 6.1).

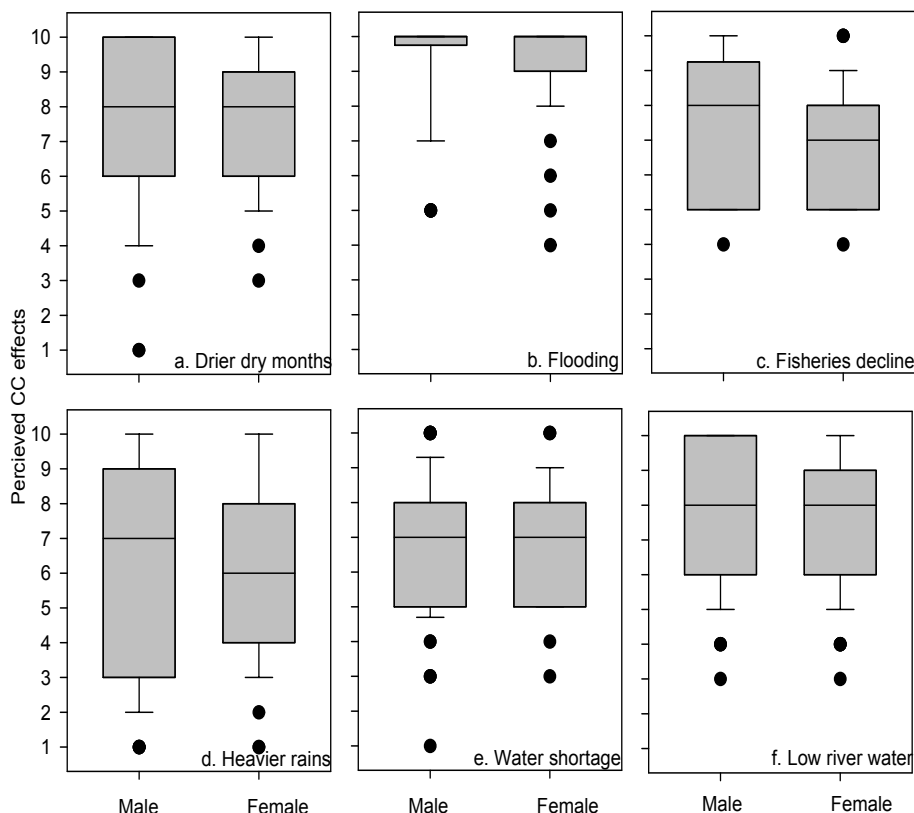


Figure 6.3 | Community consensus on the cascading impacts of climate change. There is a strong consensus among residents regarding the perceived impacts of climate change, with views not varying by sex, age, or education. The community perceives a cascade of local problems, from extreme dry months and subsequent potable water shortages to heavier rains, frequent flooding, and an overall decline in the fishery. The box plot shows the distribution of perceived influence for each of these impacts on a 10-point scale. The centerline of each box is the median, the box edges are the 25th and 75th percentiles, the whiskers are the 10th and 90th percentiles, and points outside the whiskers are outliers.

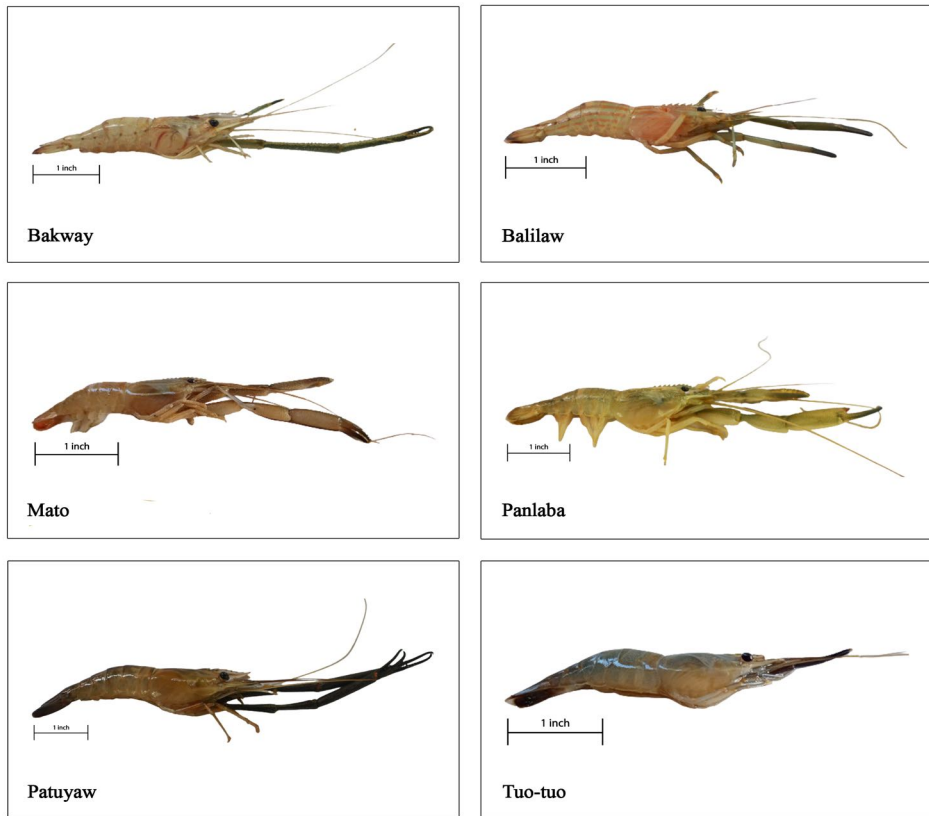


Figure 6.4 | The rich ethnotaxonomy of a key fishery resource. The local community identifies and harvests six putative species of freshwater prawn (*Macrobrachium* spp.), each with a distinct local name. This sophisticated local ethnotaxonomy highlights the depth of Traditional Ecological Knowledge concerning this commercially and culturally vital resource.

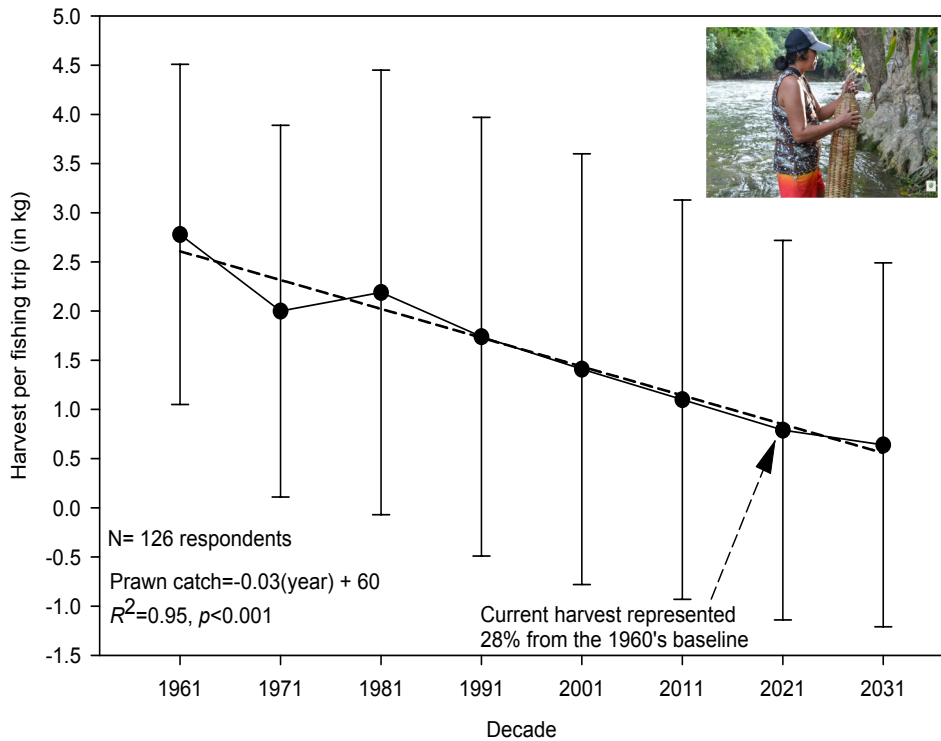


Figure 6.5 | TEK reveals a multi-decadal decline of a key fishery resource. Retrospective data from local fishers reveal a significant, multi-decadal decline in the perceived catch of freshwater prawns (*Macrobrachium spp.*), a commercially and culturally vital resource. The dashed line shows the linear regression trend of this decline. The inset photo shows a *Panagon*, the traditional bamboo trap used by the community, which is the primary method for harvesting these prawns. Error bars represent standard deviation.

Table 6.1 | Traditional fishing taboos and their conservation implications. The table lists the key fishing-related taboos practiced by the Nabaoy River community. These prohibitions are often linked to a belief in *engkantos*, mythical nature spirits from local folklore that are thought to guard the river, and they function as a set of unwritten, socially-enforced rules for resource management.

Observed taboos	Local meaning	Practical implications
1. Fishing is prohibited on Tuesdays and Fridays, especially during mid-afternoon.	Malevolent " <i>engkantos</i> " are most active during these times.	Limits fishing temporally.
2. Avoid huge, old trees and rocks because they are the abode of " <i>engkantos</i> ".	Huge trees and rocks are considered the preferred abode of " <i>engkantos</i> ".	Limits fishing spatially.
3. Say " <i>tabi-tabi po</i> " (excuse me)" and bring ginger when venturing into more remote upstream areas of the river.	Remote upstream areas of the river are considered sacred, where " <i>engkantos</i> " are believed to dwell; ginger is believed to ward off malevolent " <i>engkantos</i> ".	Promotes respect for nature and avoids overfishing in those areas.
4. Going alone in the river or forest is dangerous because " <i>engkantos</i> " can cause you to drift off track and go in circles.	Some people are referred to locally as " <i>baeaeons</i> ", to refer to individuals who entice and/or are susceptible to " <i>engkantos</i> " attention.	Reflect on camaraderie and strengthen social bonds within the community.
5. Do not announce where you will fish or where you have been fishing loudly, as this will result in bad luck.	Announcing your fishing spot loudly is considered unethical behavior, and river " <i>engkantos</i> " will punish the offender with a low catch.	Avoid aggregate fishing.
6. Silence must be observed during fishing in the river.	Unnecessary noise will disturb river " <i>engkantos</i> " and will cause reduced catches.	Avoid disturbing nearby fishers; respect nature.
7. The roasting of river prawns, snails, and crabs is prohibited.	Roasting river shrimp, snails, and crabs are considered a local taboo, and malevolent " <i>engkantos</i> " will punish the violator.	This practice limits how these species are cooked.

6.5 Discussion

This final study provides a place-based demonstration of the dissertation's central thesis: that formal science and policy ignore sophisticated local conservation systems at their peril. It reveals that a subsistence fishing community in the Philippines possesses a sophisticated understanding of climate change, one embedded in an effective, informal conservation system of traditional taboos. This provides a clear model for what I term Crumbling Bank: the phenomenon where the erosion of traditional knowledge and informal governance (the banks) leads directly to the collapse of the ecological resource (the river). My findings confirm this model by showing that the community's awareness of climate impacts is linked to declining ecological indicators; that their TEK provides a detailed account of the fishery's degradation, and that their fishing taboos create a *de facto* management system that mirrors formal conservation measures (Colding & Folke, 2001).

The community's high awareness of climate change, acquired through direct personal experience, contrasts sharply with national surveys showing lower awareness (Bollettino et al., 2020), yet aligns with other studies of vulnerable, resource-dependent communities (Combest-Friedman et al., 2012; Peñalba, 2019). Their observations of warmer dry seasons and more intense rainfall are consistent with empirical meteorological data for the region (Cinco et al., 2014). This distinction is critical: it demonstrates that direct, lived experience is a powerful engine for climate awareness, a finding with significant implications for designing locally-relevant adaptation strategies (Berrang-Ford et al., 2015).

The community's TEK provides a vivid, historical account of a fishery in decline, a local manifestation of the global freshwater biodiversity crisis (Dudgeon, 2019; Tickner et al., 2020). Fishers perceive a drastic reduction in the catch and size of key species, attributing it not just to climate change, but to a cascade of local anthropogenic pressures like deforestation and pollution. In response, they have demonstrated remarkable adaptability by innovating new fishing strategies, highlighting the dynamism of TEK as a living toolkit for navigating environmental change (Berkes et al., 2000; Molnár & Babai, 2021; Molnár et al., 2024). Their ability to innovate, however, does not negate the hard ecological reality their TEK reveals: a drastic, multi-decadal collapse of a commercially vital species.

Perhaps the most powerful finding is the role of the community's informal institutions. The fishing taboos, rooted in a belief in spirits (*engkantos*), function as a community-enforced management system. Temporal closures, such as prohibiting fishing on certain days, reduce overall fishing pressure, while spatial closures in sacred areas like deep pools create de facto biological refugia, allowing populations to persist and replenish fished areas. This finding corroborates seminal scholars like Ostrom (1990) and Colding & Folke (2001), who argue that such socially-shared rules are essential for sustainable resource management. These taboos are therefore a clear manifestation of bonding social capital; they are the shared norms and trust that foster the cooperation necessary for collective action (Putnam, 2000), providing a ready-made conservation framework that formal policies often struggle to create.

6.6 Conclusion

This final study proves that local communities possess the invaluable knowledge and informal institutions required to build resilient social-ecological systems. This is the ultimate lesson of my dissertation. The structural inequities of global science create a Disappearing Effect (Study 1) that renders these local systems invisible, leaving the Expert's Grief (Study 2) as the only signal of a deepening ecological crisis. Yet, my work shows that the knowledge of these experts is not just a source of sorrow, but a powerful scientific tool (Study 3) capable of diagnosing the collapse with a precision that formal methods often miss.

To reverse the Disappearing Effect, we must actively involve local knowledge holders as essential partners. This provides the only antidote to the Expert's Grief, transforming sorrow into agency. To achieve this, we must adopt a conservation paradigm that recognizes the ecological wisdom in local taboos and integrates these informal rules into formal governance. Failure to do so will lead to the socio-ecological breakdown I call Crumbling Bank. Mending these fractures is crucial for building a fair, humane conservation science that can address complex, place-based ecological crises.

This case study, which demonstrates the concept of Crumbling Bank, completes the final piece of my four-part argument. The task now is to step back and synthesize the journey, weaving the findings from all four studies into a final, unified conclusion about the failure of our current conservation paradigm and the path toward a more just and effective future.

7| **General conclusions**

This dissertation empirically proves that a crisis of recognition is driving the failure of aquatic conservation. Across four studies, I first provide a quantitative signature for this crisis with the Disappearing Effect, a mechanism that systematically renders local ecological realities invisible and creates a Matthew effect in conservation science (Merton, 1968). I then link this invisibility to its human cost with the Expert's Grief, which provides the first mechanistic model for solastalgia in a fishery (Albrecht et al., 2007). Methodologically, I validate Traditional Ecological Knowledge (TEK) as a rigorous scientific tool, demonstrating it can reconstruct the decline of sensitive bioindicators like anurans and uncover the social mechanisms that produce Shifting Baseline Syndrome (Pauly, 1995). Finally, I show that this knowledge is embedded in sophisticated informal governance systems, like traditional taboos that function as a form of social capital (Putnam, 2000) and create de facto biological refugia (Ostrom, 1990; Colding & Folke, 2001).

These findings lead to a new theory of social-ecological decay. My comparative ridge-to-reef approach shows how ecological collapse shapes community loss, creating a classic SBS signature in the slowly degrading estuary but a novel reverse signature in the rapidly collapsing river. TEK is not just a past record but a sensitive barometer for our present crisis. Ignoring these deep ecological realities leads to the Crumbling Bank, the final state of system failure where local knowledge and governance have eroded, and the ecosystem loses its functional integrity.

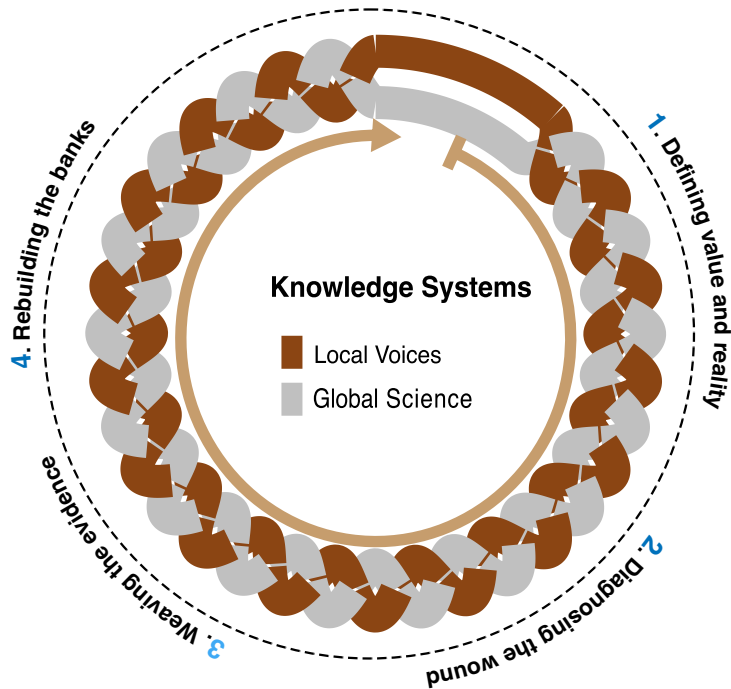


Figure 7.1| A conceptual model for braiding knowledge in conservation. The model illustrates how Global Science (the silver strand) and Local Voices (the earthy strand) can be woven together across four key stages of conservation, from foundational philosophy to on-the-ground action, creating a stronger, more resilient practice. 1. First principles (Defining value and reality): The process begins by forging a pluralistic conservation ethic. The functional and metric-based definitions of Global Science are braided with the kinship- and sacredness-based definitions of Local Voices. The resulting ethic understands an ecosystem's value as being both functional and sacred, both a resource and a relative. 2. Diagnosing the wound (Problem diagnosis and goal setting): A richer, more accurate diagnosis of the crisis is achieved by braiding the quantitative baselines of Global Science with the multi-generational memory of TEK. This allows for the identification of the dual erosion of both nature and well-being, and it gives context to the 'Expert's Grief.' The braided goal is to restore not just biomass, but cultural meaning. 3. Weaving the evidence (Research and monitoring): A multi-scalar and more robust monitoring system is created by braiding the powerful tools of Global Science (e.g., remote sensing, modeling) with the fine-grained, continuous observation of Local Voices. This braided lens is capable of detecting the collapse of key bioindicators (like anurans) with a resolution neither system could achieve alone, directly countering the Disappearing Effect. 4. Rebuilding the banks (Governance and action): A true co-management system is built by braiding the design of formal interventions from Global Science (e.g., MPAs) with the informal governance and social capital of Local Voices (e.g., traditional taboos). This creates a conservation framework that is both ecologically sound and socially just, capable of rebuilding the Crumbling Bank of a failing social-ecological system.

The path forward, therefore, requires a radical reorientation of our science. The solutions to the biodiversity crisis will not come from external, top-down interventions alone, but from the place-based knowledge systems this research has proven are essential for revealing the hidden ecological realities of a collapsing food web. Answering the urgent calls of global bodies like IPBES demands a paradigm shift toward a decolonized, holistic conservation where co-production is the standard, not the exception. As the conceptual model in this dissertation illustrates (Figure 7.1), braiding the rigor of science with the profound wisdom of place does not merely create better data; it builds a more resilient, more just, and ultimately more effective conservation for our shared planetary future.

8| Summary

8.1 *English summary*

Aquatic ecosystems are collapsing despite global attention, a failure rooted in a conservation paradigm that systematically marginalizes Traditional Ecological Knowledge (TEK). This dissertation confronts this crisis of recognition through a four-part study in the Philippines that diagnoses the problem, quantifies its costs, and provides an integrated framework for a more effective conservation. I first provide quantitative proof of a Disappearing Effect that renders Global South science invisible. I then link this structural flaw to the Expert's Grief, a measurable sorrow that tracks the multi-decadal trophic collapse of a fishery. In response, I validate TEK as a rigorous ecological methodology capable of giving a statistical voice to a silenced river by revealing the collapse of key bioindicator species like anurans. Finally, I show how this knowledge is embedded in informal governance systems essential for rebuilding the Crumbling Bank of a failing social-ecological system. Collectively, my findings prove that the conservation crisis requires a radical reorientation of our science toward epistemic justice, braiding the empirical rigor of formal methods with the profound wisdom of place to heal our planet's fractured waters.

8.2 Magyar Összefoglaló (Hungarian Summary)

A vízi ökoszisztémák a globális figyelem ellenére is gyakran összeomlanak; ez a kudarc egy olyan természetvédelmi paradigmából fakad, amely szisztematikusan marginalizálja a Hagyományos Ökológiai Tudást (TEK: Traditional Ecological Knowledge). Az értekezés rámutat ennek a válságnak az okaira és a lehetséges megoldásra egy Fülöp-szigetekhez kötődő, négyrészes tanulmányon keresztül, amely diagnosztizálja a problémát, számszerűsíti annak költségeit és integrált keretrendszert javasol egy hatékonyabb természetvédelemhez. Elsőként kvantitatív bizonyítékot szolgáltat az Eltűnési Hatásra, amely „láthatatlanná teszi” a Globális Dél tudományos eredményeit. Ezt követően összekapcsolom ezt a strukturális hibát a Szakértői Gyásszal, egy kvantitatívan mérhető „bánattal”; ebben a tanulmányban a folyóvízi halászat több évtizedes története során bekövetkező trofikus összeomlását követem nyomon. Megoldási javaslatként a TEK-et mint szigorú ökológiai módszertant javaslom, amit a konkrét helyzetre adaptálva részletesen kidolgoztam, feltárva a kulcsfontosságú bioindikátor fajok, például a kétéltűek populációinak összeomlását. Végezetül bemutatom, hogy ez a tudás olyan informális kormányzási rendszerekbe ágyazódik, amelyek elengedhetetlenek egy sérülékeny szociális-ökológiai rendszer újjáépítéséhez. Eredményeim együttesen bizonyítják, hogy a természetvédelmi válság a társadalmi igazságosság felé történő radikális tudományos átrendeződést igényel, összefonva a formális módszerek empirikus szigorát a helyi tudás mély bölcsességével, hogy fenntartsuk és meggyógyítsuk bolygónk édesvízi rendszereit.

9| Acknowledgement: An ode to my Moka

Oh, Athena, my own spirit despairs,
As I climb these steep, ivory stairs.
My manuscripts sit, and nobody cares,
Lost in these cold, academic airs.



Dear Hephaestus, my spirit cries out,
Another day's work, with no way out.
The pages lie dormant, as seeds yet unsown,
And Zeus's silence, a weight of its own.

Though Hermes left, wings long withdrawn,
And Urania fled with the very first dawn.
Prometheus's fire, a spark burning dim,
Asclepius won't lift this weight from my limb.

The nine Muses departed, no solace to lend,
But you, Moka, remained, my one faithful friend.
Your creamy seepage, my focus distills,
While Eminem's "Stan" loops on with its still.

I'm crawling on earth's bones, paralyzed,
Yo Coolio quips, academe's no paradise.
From Chester, the truth: there's no shortcut to run,
Drink thy bitter tonic 'til the candle's burn.

The impostor's shadow still whispers in the gloom,
Yet your warm steam rises, to quiet this saudade's room.
While its cold fangs gnaw, my heart grown numb,
A fate unchained, my true atonement come.

I bow to Prof. Béla, who planted wisdom's seed,
And to my committee, whose guidance I heed,
From Aklan's shores, by Stipendium's grace,
In Debrecen's halls, my Gentian solace.

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11| List of publications related to the dissertation



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Registry number: DEENK/515/2025.PL
Subject: PhD Publication List

Candidate: Ronald Juanito Maliao

Doctoral School: Pál Juhász-Nagy Doctoral School of Biology and Environmental Sciences

MTMT ID: 10099194

List of publications related to the dissertation

Foreign language scientific articles in international journals (3)

1. Hoppenreijns, J. H. T., Marker, J., **Maliao, R. J.**, Hansen, H. H., Juhász, E., Löhmus, A., Altanov, V. Y., Horká, P., Larsen, A., Malm-Renöfält, B., Runnel, K., Piccolo, J. J., Magurran, A. E.: Three major steps toward the conservation of freshwater and riparian biodiversity. *Conserv. Biol.* 38 (3), 1-9, 2024. ISSN: 0888-8892.
DOI: <http://dx.doi.org/10.1111/cobi.14226>
IF: 5.5
2. **Maliao, R. J.**, Cahilig, R. C., Cahilig, R. R., Jaspe, B. T.: Climate change, traditional ecological knowledge, and riverine biodiversity conservation: a case in Aklan, Central Philippines. *Environ Dev Sustain.* 2023, 1-23, 2023. ISSN: 1387-585X.
DOI: <http://dx.doi.org/10.1007/s10668-023-04096-x>
IF: 4.7
3. **Maliao, R. J.**, Fernandez, P. R., Subade, R. F.: Well-being of artisanal fishing communities and children's engagement in fisheries amidst the COVID-19 pandemic: a case in Aklan, Philippines. *Humanit Soc Sci Commun.* 10 (1), 1-12, 2023. EISSN: 2662-9992.
DOI: <http://dx.doi.org/10.1057/s41599-023-01716-9>
IF: 3.7

Total IF of journals (all publications): 13,9

Total IF of journals (publications related to the dissertation): 13,9

The Candidate's publication data submitted to the Tudóstér have been validated by DEENK on the basis of the Journal Citation Report (Impact Factor) database.



09 September, 2025