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See Sea - The Paradise And Consciousness: Environmental Transition And Climate Impacts On The Sea Nomads (Bajau Laut)

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Abstract: *This article explores how people interact with the environment and examines the social, livelihood, and health impacts of climate change on fishing communities. These challenges are particularly formidable for traditional seafaring communities such as the Bajau Laut, whose lives are deeply connected to the sea. The Bajau Laut's historic mobility functioned as an ecological regulator, balancing human subsistence with marine ecosystem productivity. This balance has shifted due to rising environmental damage, overfishing, socio-political exclusion, and displacement to semi-permanent coastal settlements. We highlight how Bajau Laut's relationship with their marine and coastal environment is evolving, and how environmental changes, statelessness, and socio-economic marginalisation heighten ecological risks. Combining literature research with photographic and video documentation, it places the Bajau Laut within broader discussions on environmental justice, coastal ecosystem sustainability, and the resilience of marginalised maritime communities.*
Keywords: *Bajau Laut; Sea Nomads; environmental marginalisation; marine sustainability; coastal adaptation; statelessness; environmental anthropology*

1. INTRODUCTION

The Bajau Laut, a long-established maritime community dispersed across the Sulu–Sulawesi region, has traditionally practised a semi-nomadic lifestyle, moving through coral reef systems and shallow coastal zones. This paper focuses on the Bajau Laut of Semporna, Sabah, whose livelihood and cultural identity are closely linked to fishing and the collection of marine resources (Sather, 1997). Their interactions with the sea reflect a deep reservoir of ecological knowledge and insights into local tides, currents, and aquatic species, which is still transmitted to younger generations through oral tradition. In recent decades, nation-state territorialisation, industrial-scale fishing practices, and climate-induced environmental change have substantially constrained the Semporna Bajau Laut's access to marine environments, creating new migration difficulties. Their once-fluid patterns of mobility have been disrupted, replaced by forms of confinement shaped by ecological degradation and political regulation. These constraints intersect with social marginalisation, statelessness, and residence in increasingly polluted coastal areas. This paper investigates the ecological developments of this transformation, emphasising the interconnected nature of maritime ecosystems and the community's ongoing struggle for survival.

2. THE RHYTHM OF LIFE: COASTAL MOBILITY

For the Bajau Laut, mobility is not merely about movement; it symbolises their profound bond with the sea. Their movements are coordinated with monsoon shifts, tide patterns, and moon cycle phases. Drawing on centuries of experience, families build their own boats to navigate the sea, while physical adaptations enable individuals to routinely free-dive for extended periods. This lifestyle is characterised by ingenuity and simplicity, with stilt-house designs adapting to climate variations and makeshift water-collection techniques. Their mobility embodies a relational ethic, seeing the sea as a mentor, companion, and spiritual source, rather than just a resource for survival.

2.1 MOBILITY AND MARINE INTIMACY

The Bajau Laut traditionally exhibited a nomadic lifestyle characterised by fluid, non-linear movement across vast oceanic regions rather than by establishing permanent land settlements. They utilise traditional wooden boats known as lepa-lepa or lipa-lipa, which function as both living quarters

and workspaces, thereby supporting their itinerant way of life. These vessels, typically 5 to 10 meters long, are equipped with sails and outriggers for stability and can accommodate entire families. The maritime movements of the Bajau Laut are closely tied to ecological patterns rather than occurring randomly. They consistently monitor their environment, adapting their activities to variations in marine resource supply, monsoon seasons, and tidal movements (Sather, 1997). During the inter-monsoon periods from March to May and September to November, when the seas settle, they journey offshore to catch pelagic fish such as tuna and mackerel. The more turbulent northeast and southwest monsoons, from December to February and June to August, guide them inward toward lagoons and coral reefs, where they depend on inshore resources. The lunar calendar also guides their daily decisions; neap tides open safe routes through shallow coral systems, and full moons provide better visibility for nighttime fishing. The "seascape epistemology," is a spatial understanding shaped through physical interaction, intergenerational narratives, and perceptual familiarity with the sea's dynamics (Ingersoll, 2016). According to Bajau Laut, the ocean appears as a patterned environment, composed of routes, currents, and inherited points of reference rather than an open void. Their mobility is deeply connected with spiritual, artistic, and physiological bonds to the sea. These relationships are reflected in their extraordinary bodily adaptations, which showcase what can be called "somatic intimacy" with marine life. Decades of experience have honed free-diving skills that allow locals to dive between 30 and 70 metres without scuba gear. The Bajau Laut's technological adaptations serve as an additional means of supporting their ecological mobility. They still craft much of their fishing equipment by hand, shaping spears, hooks, and other tools to showcase their personal skill and the natural patterns of their maritime environment. For the Bajau Laut community, the sea is much more than just a place to find food; it serves as a living repository of knowledge, a spiritual partner, and a space that imparts lessons through lived experience. Recent scientific studies (Ilardo, et al., 2018), highlight their impressive adaptation to marine environments, particularly their enlarged spleens that enhance oxygen storage during dives. These traits, formed over thousands of years of close interaction with aquatic environments, reveal an unusual merging of human physiology with the maritime cosmologies. Since childhood, the practice of mag-ambol (breath-hold diving) has enhanced not only physical endurance but also the intuitive, underwater awareness that modern technologies still find difficult to replicate. Within the Bajau Laut community, mobility reflects a division of labour by gender and age. Women work on reefs and manage household duties, men embark on long-distance spearfishing trips, and children raised in the water acquire a natural sense of spatial orientation and swimming ability. These shared labour practices enable flexibility which enable Bajau Laut families to quickly relocate during environmental crises, overfishing, or territorial disputes. However, their traditional mobility is constantly constrained by external pressures. Marine protected areas, climate-driven sea level rise, and state policies enforcing sedentarisation now limit their freedom to move across the Sulu-Sulawesi seascape (Dollah, 2025). The stilt-house villages of Kampung Bangau-Bangau in Semporna, Sabah, (Figure 2b, Right) provide the latest proof that many communities in Malaysia today live in land-and-sea hybrids. Modernisation, environmental regulation, and state territorial control are reshaping the Bajau Laut's traditional mobility, marking an essential phase in their social and cultural history. From a "Cultural Intimacy" point of view, daily social activities and relationships are all aspects of the Bajau Laut's culture as a family. In addition to affecting fishing practices, tides and moon phases also influence social life; high tides stimulate social occasions, such as gatherings to share meals, tell stories, and trade, while low tides bring family members together to forage for sea cucumbers and shellfish. Preparing meals within the community promotes social cohesion and encourages nutrient sharing across society. Children develop their environmental awareness through activities such as diving, interpreting waves and weather patterns, and identifying marine species. These activities integrate physical experience, environmental understanding, and local knowledge to create an embodied ecology.

In "Spiritual Intimacy," an animistic cosmology is revealed through the spiritual practices of the Bajau Laut, where guardian deities and ancestral spirits (jin) are believed to animate the sea. To maintain cosmic balance, offerings such as rice, tobacco, or walnuts are presented before fishing

expeditions or following plentiful catches. Funerary traditions, including boat-shaped tombs and sea burials that represent the cycle of life, death, and the sea, evoke a reunion with the marine womb.

These perspectives diverge from the resource-driven approach of commercial fisheries, providing the Bajau Laut with an alternative understanding of the sea and a relational ethic. The Bajau Laut community regards the sea as an active presence in their lives, making reciprocity central to daily practice. They foster a form of ecological coexistence that sustains equilibrium between human needs and the ecological rhythms of the sea.

2.2 MATERIAL SIMPLICITY AND ADAPTIVE RESILIENCE

The Bajau Laut settlers demonstrate distinctive adaptive resilience through their use of found objects and raw materials. Although the stilt villages around Semporna appear peaceful, with tranquil rivers and picturesque views, residents face resource shortages and employ inventive methods to survive without urban amenities. For instance, makeshift rainwater collection systems made from barrels or gutters in areas lacking piped water are vital for drinking and washing. Kerosene lamps provide minimal illumination in the dark hours, and crude solar panels, sometimes made from inexpensive or scavenged materials, generate little electricity for charging devices or powering small appliances, helping bridge the grid deficit.

Reliance on traditional methods is often imposed on individuals because of inadequate healthcare and educational infrastructure. Therapeutic remedies from local herbs, marine resources, or ancestral recipes treat a myriad of conditions, from minor wounds to chronic ailments, and reveal susceptibilities to modern disease. In such situations, it is not that education is not found within the confines of classrooms. Rather, it is maintained through oral knowledge systems, where elders teach fishing, crafting, navigation, culture, and any knowledge about these things through oral stories and demonstrations. The balance between adaptability and vulnerability is clear in the design of the settlements. Settlements built on bamboo stilts help prevent flooding and tidal surges, while palm-leaf roofs ensure proper ventilation and insulation in humid environments. The shelter is made from driftwood or salvaged timber from abandoned ships. It is a design that protects its residents from natural threats like storms and rising sea levels, highlighting the conflict between humanity and the changing ocean horizon caused by climate change The accompanying photos (Figures 1a - 1f) vividly illustrate this peaceful yet perilous lifestyle. Images of stilt houses above the water signify structures of craft; boats moored beside the water represent mobility and a source of income; fish drying on racks represent a sustainable way to store and preserve food; outdoor laundry lines blowing in the breeze represent a social way to do laundry. Brightly coloured water buckets add vibrant pops against muted tones. These elements are combined, working together to give a very compelling and harmonious structure that highlights ecological cohabitation – it shows how human ingenuity works with nature to adapt to environmental adversity, thereby forming a pattern of eco-dynamic coexistence.

3. ENVIRONMENTAL IMPACTS - WASTE, POLLUTION, AND THE BREAKDOWN OF MARINE SYMBIOSIS

The Bajau Laut now live in densely populated stilt settlements rather than leading a fully nomadic, maritime lifestyle. This change has turned a previously scattered flow of biodegradable waste into a concentrated accumulation of plastics, sewage, and household rubbish. The situation has worsened due to poor waste management and increased dependence on manufactured products. These pollutants now suffocate coral reefs, harm seagrass beds, and disrupt the delicate symbiosis that sustains reef health. As habitats decline, fish stocks dwindle, forcing fishermen into deeper and more perilous waters and heightening economic instability. These combined pressures signal a broader ecological breakdown that endangers both local biodiversity and the cultural traditions closely linked to the sea.

3.1 FROM DISPERSED WASTE TO CONCENTRATED POLLUTI

Asa nomadic community, the Bajau Laut generated minimal biodegradable waste consisting of fish scraps, plant fibres, and human faeces, which the tides and currents gently carried away along long

sea passages. Indigenous ecological knowledge considers water as a self-regulating absorber of organic matter; the semi-nomadic nature of the lepa-lepa houseboats prevented localised build-up, thereby protecting essential fish habitats such as coral reefs and seagrass habitats. Due to government relocation efforts, climate change, and statelessness, more of Semporna's Bajau Laut are settling in stilt villages. This trend has restricted their mobility and increased their reliance on synthetic products such as disposable items, plastics, and nylon nets. Municipal waste facilities are often inaccessible to non-citizens. Burning or discarding plastics, food scraps, and untreated sewage releases pollutants such as dioxins, furans, and other harmful particles into nearby waters, worsening air pollution and contributing to respiratory diseases.

Figure (1a – 1f) Y.W. Alex Wong, Drone Photography (Inclusion of Environment). Dji Mavic 2 Pro. Semporna, Sabah, Malaysia.

This modification transforms an adaptive transfer cycle into a closed loop. Microplastics disrupt marine food webs, persistent plastics entangle fishing gear, leading to declines in catches and hence incomes and food security, and macro-debris suffocates corals, hindering photosynthesis and larval settlement. This dilemma is illustrated by visual ethnography (Figures 3a - 3d), where cluttered houseboats are filled with drifting garbage, shallow tidal litter is found under homes, trash-choked shorelines are prevalent, and toddlers crisscross mountains of trash. The Bajau Laut remains utterly

dependent on the sea to define who they are and for their subsistence. However, they are now engaged in a vicious cycle in which they and the environment they once relied on are mutually endangering each other. This apparent contradiction highlights the crucial importance of culturally appropriate and effective environmental governance in waste management.

3.2 ENVIRONMENTAL FEEDBACK AND ECOLOGICAL ENTRAPMENT

The growing amount of waste and increasing marine pollution around the Bajau Laut's living environment now threaten their coastal livelihood by damaging the coral reef and seagrass ecosystems that have long supported them. Plastic debris, chemical by-products from open burning, and untreated sewage build up on reef surfaces, suffocating coral polyps and disturbing their symbiotic exchange with zooxanthellae. This imbalance often causes widespread coral die-off. These stresses reduce reef resilience and hinder their ability to recover from climate-related stressors, such as the significant bleaching events in 2016 and 2024 (Szereday, et al., 2025). Once-abundant fish populations that thrived within paddling distance of stilt-house settlements are now declining, affected by habitat fragmentation and the loss of critical nursery grounds for juvenile fish.

Now, fishermen must go further offshore into treacherous, deeper seas with just hand-lines and crude spear tools. The distance is limited by both fuel constraints and the fragile system of outrigger canoes, which means the number of men in the field is reduced, and the physical danger is increased. Semporna's catch-per-unit-effort statistics suggest a 30–40% drop in daily hauls that is correlated with measures of reef health over the past decade (Choo, et al., 2025). The process of decay thus triggers an ecological feedback loop of ill-advised exploitation. Reduced marine output increases poverty, leading to the overuse of what remains by people using fine mesh nets, dynamite fishing, or even gleaning in contaminated shallows, thereby hastening habitat destruction. Poverty drives people to dispose of plastics improperly, such as burning them or avoiding collection points, which perpetuates a harmful cycle. The Bajau Laut, being stateless, are excluded from municipal services and environmental subsidies (tax incentives, credit loans, price support and market regulations), which only worsens this problem. This ecological entrapment risks irreversible loss of biodiversity and cultural survival, turning the sea from a provider into a jail in the absence of state infrastructure, floating garbage bins, composting latrines, and reef restoration co-managed with communities.

4. COASTAL TRANSITION AND THE ECOLOGY OF SEDENTARISATION

The Bajau Laut, inhabiting the Sulu-Sulawesi marine corridor, have undergone a major socio-ecological transition from pelagic mobility to coastal sedentarisation. This transition, which has accelerated since the latter half of the 20th century, is driven by converging geopolitical imperatives, including the establishment of exclusive economic zones, the delineation of maritime boundaries, and stricter fisheries governance. Seasonal migration once created vibrant seascapes, but today sedentarisation has led to populations grouping in densely built stilt-house communities with poor water flow, causing waste accumulation and harm to fragile intertidal ecosystems.

4.1 FROM THE SEA NOMADISM TO SHORELINE SETTLEMENT

The endemic statelessness worsens these issues by restricting cross-border movement, access to public services, and legal recognition. Confined within limited coastal areas, plastics, sewage, and abandoned fishing gear quickly accumulate, harming mangroves, seagrass beds, and nearshore reefs that are vital for local livelihoods. Sedentarisation is a socio-ecologocial process, whereby political marginalisation and environmental vulnerability reinforce one another, ultimately leading to a decline in ecosystem services and increased human health risks. Dropped into a sedentary lifestyle on land lacking guidance of the sea, Bajau Laut youth turn to drugs and glue sniffing, becoming a nuisance in the eyes of the public. Detrimentally, this leads to further social marginalisation and vulnerability.

As observed in Figures 2a (Left: expansive aerial perspective) and 2b (Right: micro-scale structure density), Bajau Laut populations have coalesced into densely packed, semi-permanent stilt-house communities within intertidal matrices. Such excessive residential clustering promotes waste accumulation, nutrient overloading and chronic pollution in small lagoons. This rapid and vastly

undocumented demographic consolidation exacerbates the situation. It modified accretionary patterns leading to lower tidal exchange and fragmentation of mangrove ecotones, which are essential for shoreline stabilisation and aquatic recruitment. These vernacular stilt architectures illustrate adaptive bricolage using detrital materials, structurally disrupting hydro-sedimentary regimes. Consequently, previously dynamic seascapes (as determined and shaped by low-intensity nomadic extractivism) are now static, ecologically compromised systems subject to eutrophication, accelerated erosion, and decreased biodiversity. This highlights the recurring relationship between environmental degradation and socio-political marginalisation in human-marine interfaces.

Figure 2a (Left) & 2b (Right). Y.W. Alex Wong, (Inclusion of Environment). Dji Mavic 2 Pro. Semporna, Sabah, Malaysia.

4.2 POLLUTION AND COASTAL HABITAT DEGRADATION ACROSS THE SEA-LAND CONTINUUM

As shown in the images (Figures 3a - 3d), the integrity of the benthic and pelagic ecosystems in Bajau Laut stilt-house habitats is compromised by human waste (e.g., PET plastics), abandoned fishing gear, and labile organic compounds. Without dedicated waste management systems, disposal occurs either through (i) supratidal discards (with plasticisers and trace metals leaching into hyporheic streams) or (ii) open burning (releasing PM_2.2, polycyclic aromatic hydrocarbons, and persistent organic pollutants). Macroplastics immobilise megafauna by damaging epibenthic substrates, while filter-feeding vectors spread microplastics (<5 mm). This litter reduces gross primary production and cryptofaunal refugia by obstructing seagrass (Thalassia hemprichii) canopies and scleractinian larval settlement. Consequently, demersal fisheries are declining, which hampers subsistence viability.

Bidirectional contaminant advection drives disturbance: monofilament nets and allochthonous[1] microplastics accumulate on the land surface through storm surges, whereas terrigenous[2] litter exports seaward via ebb currents. Advective-dispersive flushing is obstructed by stilt infrastructure with consequent expansion of the lentic microhabitats, decreased oxygen to minimum level, and pathogen enrichment (Shigella dysenteriae[3], Vibrio cholerae[4]). The positive feedback chain of benthic anoxia[5], trophodynamic[6] collapse, and human communities with epidemiological vulnerability is perpetuated by the abundance of faecal indicator bacteria and hypertrophic factors, leading to endemic cholera, shigellosis[7], and pyoderma[8] (Santodomingo, et al., 2021).

Figure 3a (upper left), 3b (upper right), 3c (lower left) and 3d (lower right). Y.W. Alex Wong, (Inclusion of Environment). Iphone15Pro Max. Semporna, Sabah, Malaysia.

[1] Allochthonous - denoting sediment or rock that originated at a distance from its present position.
[2] Terrigenous - (of a marine deposit) made of material eroded from the land.
[3] Shigella dysenteriae - bacteria (germs) that cause diarrhea, fever and stomach pain.
[4] Vibrio cholerae - a species of Gram-negative, facultative anaerobe and comma-shaped bacteria. The bacteria naturally live in brackish or saltwater where they attach themselves easily to the chitin-containing shells of crabs, shrimp, and other shellfish.It is a bacterium that causes cholera, a deadly diarrhea disease.
[5] Benthic anoxia - oxygen minimum and ecological region at the lowest level of a body of water such as an ocean or a lake, including the sediment surface and some sub-surface layers.
[6] Trophodynamic - refers to the "dynamics of nutrition or metabolism," was first proposed by Lindeman (1942) and is fundamental in understanding the flow of energy through food webs.
[7] Shigellosis - represents an acute diarrheal illness caused by enteroinvasive Shigella species capable of producing severe inflammation and a wide clinical spectrum ranging from watery diarrhea to dysentery.
[8] Pyoderma - a cutaneous infection with pyogenic (pus-forming) bacteria. Although the term pyoderma literally means "pus in the skin," the pus may not always be visible to the naked eye.

5. CLIMATE IMPACTS - AN ELEGY FOR THE BAJAU LAUT IN THE ANTHROPOCENE

The sea has always been a vital part of the Bajau Laut's daily lives. Nevertheless, it is currently their biggest overall threat. The Bajau Laut are among the groups most affected by climate hazards globally, according to expert research, relief organisation updates, and testimonies. Their previous way of life is now considerably more difficult to maintain due to climate change, which contributes to rising sea levels, intensifies storms, progressively erodes coastlines, and seriously damages the coral reefs on which they depend for survival.

5.1 RISING SEA LEVELS

Sea levels are rising rapidly in this region. Currently, most Bajau Laut people in the Coral Triangle are

neither afraid nor aware of the danger. Projections from the Asian Development Bank suggest that some low-lying stilt settlements could become uninhabitable within decades (ADB, 2014). Deteriorating pathways and walkways, permanently submerged floors, and children playing in knee-deep water during mornings are familiar sights. As tides continue to rise, many water communities on islands like Omadal and Maiga in Sabah, Malaysia, have been abandoned. Moving to solid land is a critical cultural dislocation and a logistical challenge for the Bajau Laut, whose identity is deeply rooted in living directly above the reef.

5.2 UNPREDICTABLE WEATHER AND SEVERE STORMS

The monsoon is no longer a dependable indicator of safe fishing periods. Typhoons are increasing in frequency, lasting longer, and causing bigger seas with stronger winds. Travel by sea was once routine, but now is risky as traditional wooden boats are frequently damaged or destroyed by sudden storms. According to the elderly in Semporna, Malaysia, the sea used to be quiet in April or May, but now it is often dangerous until September or October. The safe fishing window is shorter now, which means less revenue and fewer food sources. When severe storms like Typhoon Rai (Odette) struck the region in 2021, Bajau Laut settlements suffered disproportionate damage due to their vulnerable coastal locations and the lack of official warning mechanisms (Yusof, 2021).

5.3 SHIFTING SHORES AND VANISHING COASTS

Once located hundreds of meters away from the coast, these settlements are now either perched on the ocean edge or fallen into the sea. This exacerbates poverty and cultural disruption among one of the world's last maritime indigenous peoples by forcing the communities to relocate repeatedly, losing ancestral grave sites, and becoming more dependent on the remaining overcrowded islands. Many Bajau Laut communities are situated on rapidly eroding sandy peninsulas or barrier plains which are rapidly degrading. Rising sea levels are triggering the narrow beaches used for boat landings and temporary shelters to erode at startling rates. According to satellite data, imagery and local reports, significant changes have occurred on several peninsulas over the last 20 years, from 2005 to 2025 (Google Earth Pro, 2025). Likewise, the high tides in the Tun Sakaran Marine Park have reduced the shorelines of Bodgaya and Bohey Dulang islands by 30–70% over time.

5.4 THE DISAPPEARING REEFSCAPE AND MARINE SPECIES

Ocean acidification and warming pose the most subtle yet significant threats. Some reefs in eastern Sabah have lost more than eighty percent of their living coral cover, as reported by the Global Coral Reef Monitoring Network and Reef Check Malaysia (RCM, 2024). Fish populations decline drastically when reef structure is lost. Once sustainably exploited, species like Napoleon wrasse, sea cucumbers, and groupers are now rare. In trying to find these increasingly elusive species, fishers have to take greater risks in their fishing practices, including travelling further, and diving deeper and longer. Consequently, decompression sickness becomes a more frequent threat, and is more likely to happen in a community with limited access to medical facilities. Some individuals, driven by desperation, turn to destructive and illegal activities such as blast fishing and cyanide fishing, which damage the very ecosystems they depend on (CSIS, 2019).

5.5 THE GEOGRAPHY OF DISPLACEMENT

Climate change brings a suite of biophysical hazards to the Bajau Laut, including rising seas, harsher storms, bleaching reefs, warming waters, changing coastlines, and shrinking marine species populations. Together, these processes deplete fisheries resources and alter historic migration routes. Their impacts are magnified by entrenched marginalisation linked to widespread statelessness, with roughly 40–85% of Bajau Laut in Malaysia and the Philippines lacking official documentation or citizenship (Wan and Diana, 2020). Their nomadic lifestyle and prior boundary conflicts prevent them from accessing legal protections, making them disproportionately vulnerable to disasters such as typhoons or marine degradation (Acciaioli, et al., 2017). They are further denied government disaster aid, climate-adaptation resources, fundamental education, healthcare, and various legal rights (Brunt, 2013). When they are driven onshore due to climate-related displacement and relocated to urban squatter communities, they risk losing their maritime skills, such as free diving and boat building.

6. SHIFTING SEAS - ECOLOGICAL IMPACTS ON MARINE SPECIES AND FISHERIES

Sabah's reported traditional (i.e., small scale) fish catch has fluctuated over the past decade, and overall exhibits a declining temporal trend (Figure 4). While not officially recorded in Sabah fisheries statistics, Bajau Laut fishers also face diminishing fish catches. Their key target species, such as groupers, snappers, lobsters, giant clams, and sea cucumbers, among others, are increasingly affected by overfishing, pollution, and habitat destruction. Many of the reef fish targeted by Bajau Laut have a high market value, especially those that are preferred for the live reef fish trade. Populations of the most valuable species, such as *mameng* (humphead wrasse, *Cheilinus undulatus*), *kubin* (humpback grouper, *Cromileptes altivelis*), and *sunnoh* (coral grouper, *Plectropomus* spp.) have decreased drastically in Sabah's reefs (Scales, et al., 2007). However, while these reef fish are extremely expensive for the end consumer (usually Chinese diners in other parts of Malaysia or Asia), Bajau Laut fishers only sell the fish for a fraction of the end price. This pervasive inequity in the fish value chain is facilitated by the Bajau Laut's low socio-economic status, which makes them vulnerable to being exploited.

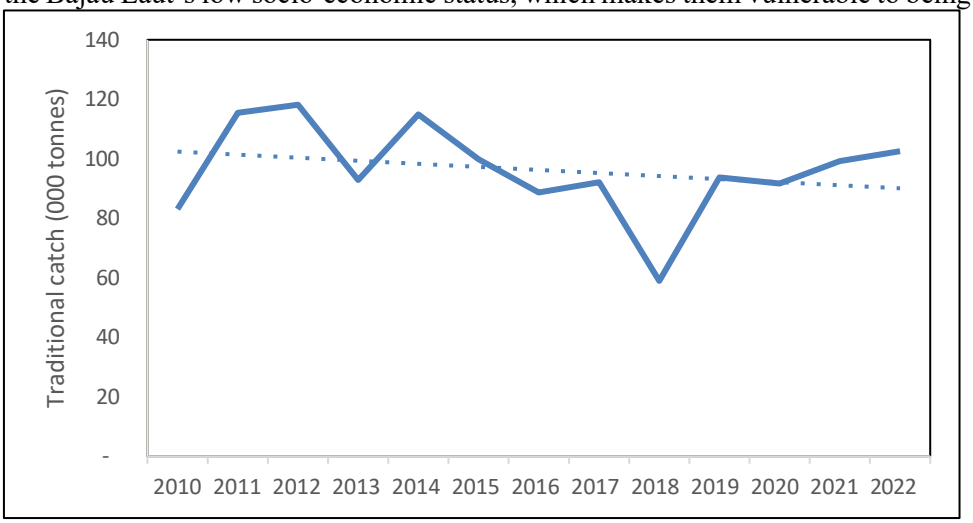

Figure 4. Temporal trend in reported fisheries catch (000 tonnes) by traditional fishers in Sabah. Source: Data extracted from Malaysia Department of Fisheries Annual Fisheries Statistics from 2010-2022.

As one of the most vulnerable ecosystems on earth, coral reefs have already been drastically affected by global warming trends. Semporna, which has the highest coral reef density in Malaysia (Waheed and Hoeksema 2012; Jolis and Saleh 2015), is likely to be particularly affected by upcoming climate impacts; this will further exacerbate the ongoing anthropogenic pressures exerted on coral reefs (Choo, et al., 2025). Projections by Kay et al., (2023) indicate that Southeast Asian seas, including Sabah, are projected to warm by an average of 1.1-2.9 °C throughout the 21st century, with dissolved oxygen decreasing by 5 to 13 mmol m^{-3} and pH falling. To illustrate, Figure 5 show historical and projected sea surface anomalies[9] for Sabah under RCP 8.5 (i.e., high climate change, indicated by the orange line), and RCP 4.5 (i.e., low climate change, indicated by the blue line). Projected end of century temperature under RCP 4.5 (1.5°C) is enough to cause thermal stress that leads to coral bleaching. Under RCP 8.5 (2.7°C), the temperature increase is likely to cause widespread coral loss (Kay et al., 2023). These projections have drastic implications for the human well-being of Bajau Laut and other coastal communities throughout Sabah. Warming oceans likely means that some species may not be adapted to temperature, pH, and oxygen levels that are outside their current range of variability. For instance, reef dwelling species such as groupers are expected to decline, while small pelagics e.g., sardine, herrings and mackerel are likely to re-distribute in response to the change in their habitat conditions (Kay et al., 2023). This means that fishers may have to change their current fishing patterns by travelling further, or to different places to find target species, or shift to catching different species. Besides the possibility of having to acquire new fishing skills, fishers may also have to invest in alternative gears and/or larger vessels. The Bajau Lauts'

limited financial capital and education presents a major barrier to adapting to change, leading them to a situation where they are faced with dwindling catches and an inability to purse alternative economic opportunities.

[9] The anomaly is equivalent to the difference between annual projected mean sea surface temperature and the historical mean (measured from 1980-2005).

Climate-related stress worsens existing socio-ecological problems, further reducing the resilience of Semporna's coral reefs. On top of this, the rapid expansion of unregulated tourism in Semporna adds multiple pressures to the shallow coastal reef environment. These pressures, such as poor waste management, unchecked tourism and resort development, limited marine awareness among visitors, and high demand for seafood, damages reef habitats and species (Teh and Cabanban, 2007). Ultimately, the marine resources which Bajau Laut depend on to support their well-being are increasingly at risk. In fact, interviews conducted over a decade ago already indicated that Bajau Laut fishers found it more difficult to find reef fish compared to the past (Yusah and Wood, 2014). These challenges, coupled with limited financial and educational resources, increase vulnerability and exacerbate socio-economic disparities in coastal communities.

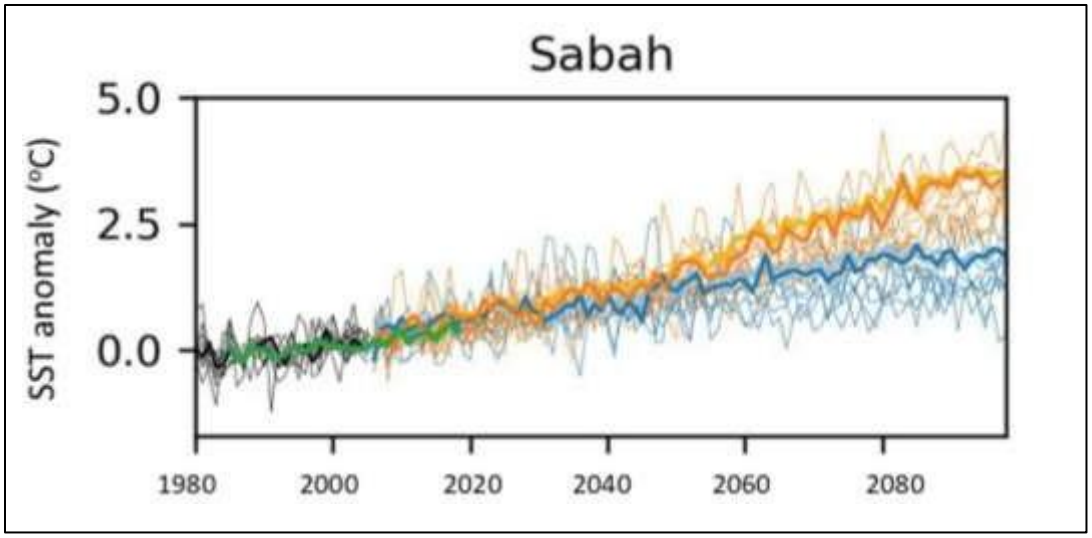

Figure 5. Anomaly in annual mean sea surface temperature for Sabah, compared to the mean for 1980-2005 (modified from Kay, et al., 2023).

Life on the water has never been easy, yet the Bajau Laut persist with quiet strength. The Bajau Laut can sense approaching storms, track seasonal fish migrations, and identify reefs that endure. In the face of climate change, they are finding modern solutions and new ways to adapt, like floating solar panels, reinforced shelters, and mangrove restoration. They remind us that resilience is as much about knowledge and culture as it is about technology.

These initiatives, however, cannot expand or stabilise without fair legal systems that validate the Bajau Laut's singular maritime identity and address the factors sustaining their statelessness. Stateless nomadic communities are seldom included in transnational efforts such as the Coral Triangle Initiative on Coral Reefs, Fisheries, and Food Security (CTI-CFF, 2016), reinforcing persistent gaps in regional climate-resilience planning. The Bajau Laut's situation reveals the uneven consequences of human-driven climate change, which threaten not only their homes and subsistence practices but also a centuries-old maritime lifeworld, one of the few remaining pelagic civilisations.

7. RESTORING BALANCE - SOCIAL INCLUSION AND THE FUTURE OF MARINE SUSTAINABILITY

The interaction between the sea and the coast shapes the environmental narrative for the Bajau Laut. Historically, human impact was distributed over a large area, and migration between marine territories sustained resource resilience, establishing an ecological modulator. Conversely, higher

levels of sedentary behaviour have concentrated environmental stress, which has been linked to greater social-economic and environmental susceptibility. Today's shore is a symbol of incarceration and ecological captivity in stark contrast to the past, when water was an emblem for liberation and nourishment. We need an intervention for the future that acknowledges this continuum. Sustainable solutions are those which integrate the following frameworks:

7.1 RESTORATION OF CORAL REEFS AND MARINE CONSERVATION Coral reef conservation is crucial for preserving Bajau Laut livelihoods and providing a biological foundation by safeguarding marine resources, including their biological components, thus helping to regenerate vital reefs. Coral reefs are biophysical regulators that provide nursery grounds for fish, cycle nitrogen, and offer complex habitats critical for healthy fish populations that support subsistence and small-scale fishery operations. In the past, adaptations such as seasonal migration, spatial dispersion, and rotational fishing reduced anthropogenic pressures on coastal ecosystems, allowing disturbed reefs to recover. Nonetheless, currently, sedentarisation and limited access to customary territories lead to overfishing, coral reef erosion, and trophic imbalance. Hence, scientific methods focusing on coral transplantation, artificial reef building and keystone species conservation must incorporate ecosystem-based management (EBM) and nature-based solutions (NbS). In addition to enhancing ecological resilience, co-management that incorporates Bajau Laut communities in participatory monitoring and reef stewardship also reinstates traditional ecological knowledge (TEK), a crucial component of adaptive management within the coastal resource management system. Transparent enforcement and competent governance have to be in place to support EBM and NbS. These are big long-term goals, but crucially needed for achieving restoration. A cautious approach to fast development, whether it is tourism or number of vehicles on the road, must also prevail to prevent upending restoration efforts. The shoreline and sea are inseparable, yet their connection is fragile. Keeping the coast and sea connected is not something that happens overnight. To keep the shoreline and sea connected, efforts cannot stop at short-term solutions.

7.2 WASTE AND SANITATION INFRASTRUCTURE AT A COMMUNITY SCALE

As this transition from nomadic sailing to shore-based settlements spreads to coastal enclaves with dense populations and no official infrastructure, it poses severe threats to environmental health. The interconnectedness of the Bajau Laut's social-ecological system means that ecological deterioration contributes to public health vulnerability; the lack of waste management systems amplifies the effects of nutrient loading, eutrophication, and microbial contamination of nearshore waters, which directly impact the health of coral reefs and human health.

Decentralised and community-based sanitation solutions, such as compost-based waste treatment, floating wetlands for wastewater filtration, and bio-digester toilets, should be front-lined in a sustainable intervention agenda. By applying circular economy principles, waste streams can be converted into valuable resources, such as biogas or fertiliser. To ensure cultural compatibility and local ownership, such systems must be co-designed with Bajau communities through participatory planning. By observing the state of their environment, including pollution and ecosystem health, communities gain insight and understanding through citizen science.

7.3 LEGAL RECOGNITION AND CITIZENSHIP PATHWAYS

For the Bajau Laut, being invisible in the eyes of the law is more than a bureaucratic issue; it shapes every aspect of their lives. Statelessness keeps them on the margins, limiting their participation in governance and conservation programs. At the same time, they are denied access to fundamental rights such as healthcare, education, and the secure use of natural resources (Wan and Diana, 2020). Bajau Laut communities' ability to respond to environmental and economic shocks is severely limited due to their stateless status. Legal recognition and citizenship pathways should therefore be established both for the protection of human rights and the environment. International accords, including the FAO's Voluntary Guidelines on Small-Scale Fisheries (VGSSF) and the UN Declaration on the Rights of Indigenous Peoples (UNDRIP), ensure that recognition allows the Bajau Laut to occupy and manage marine spaces legally. For the Bajau, gaining formal recognition within marine protected areas (MPAs) requires more than policy declarations. It calls for the inclusion of

their customary marine tenure systems within state-managed conservation zones. Truly sustainable futures can only be built when political recognition and ecological justice go hand in hand. Enabling the Bajau Laut to participate in shaping these policies is essential to achieving that balance.

7.4 ENVIRONMENTAL EDUCATION AND PARTICIPATORY GOVERNANCE

The community is key in the realisation of long-term environmental literacy, agency and participatory governance in the Bajau Laut ecosystems. Traditional ecological knowledge (TEK) has been transmitted through oral tradition and direct maritime experience; however, displacement to land based setttlements and educational marginalization has contributed to the decline of TEK. Grassroots organisations step in where government fails to do so. In Omadal, Semporna, a non-profit school for stateless children is a model of inclusivity and hope. Bajau Laut children are not only taught lessons in basic science, language and hygiene, but are also provided with nutritious meals during school days. More importantly, they are given the chance to reconnect with their roots through experiential marine centred activities and cultural classes. The skills and leadership that Bajau Laut children develop feed back into the community, as these children become teachers themselves to their parents and extended household. New environmental education systems such as these, in parallel with customary epistemologies, can be unified to produce a hybrid knowledge system that combines scientific and cultural perspectives on ecology.

These will then be used to foster local stewardship for waste management, legal rights, marine ecology, climate change adaptation, and support the care of children and parents. Bajau voices should also be engaged in decision-making processes that could affect their territory, such as participatory governance mechanisms involving various groups (e.g., policy dialogues, co-management committees, or community councils). Such approaches would promote social learning and adaptive co-management, allowing knowledge-based adaptive governance to respond proactively to social and ecological processes. The connection between the water and the coast is central to the Bajau Laut, not just as a home, but as the essence of who they are and how they live. When authority, mobility, traditional knowledge, and stewardship come together, the connection between land and sea becomes tangible again. By combining movement, ecological understanding, and inclusive governance, the local government can create approaches that care for both the communities and the ecosystems they depend on. Only by addressing environmental restoration, resilient infrastructure, legal recognition, and education together can the Bajau Laut's relationship with the sea be fully restored.

CONCLUSION

The Bajau Laut embody a fragile yet resilient existence. They currently face challenges such as statelessness, environmental harm, and systemic neglect, which hinder their sustainable interaction with the marine ecosystem. However, their understanding of the ocean is a potent form of indigenous ecological wisdom. Unlike their earlier sea-nomadic lifestyle, the shift to a coastal lifestyle has generated an environmental dilemma and is linked to an evolutionary cultural change. Where they were once able to respond to, and adapt to their environment, Bajau Laut now face overexploited seas that are often unpredictable; this situation will only intensify given projected climate risks and the failure of prevailing marine governance institutions to protect Semporna's coastal ecosystems.

Strengthening reef and coastal ecosystem resilience is key to securing the future well-being of the Bajau Laut. This involves initiatives ranging from fisheries management and conservation to waste management and environmental education. In doing so, it is essential to consider the Bajau Laut community as key participants in all these programmes, rather than as marginalised groups. Advancing a more equitable societal role for the Bajau Laut necessitates confronting the social-political barriers they face, and advocating for their legal recognition – actions that require collaboration from legal and human rights-based organisations. Without overcoming their socio-political marginalisation, the Bajau Laut will not only continue to face deteriorating environmental, socio-economic, and health outcomes, but will also be ill-prepared to adapt to projected climate risks. Thus, actively integrating the Bajau Laut into

mainstream society is a necessary, though challenging, step for supporting the future resilience of Semporna's coastal ecosystem and the well-being of the Bajau Laut community. Finally, *The Elusive Paradise,* a short video documentary, may provide a clearer view and feature the ongoing dilemma of the Bajau Laut's relationship with their marine and coastal environments.

VIDEO LINK

https://filmfreeway.com/TheElusiveParadise
Password: TEP

DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

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FIGURE REFERENCES

Figure 1a - 1f: Y.W. Alex Wong, author's photographs.
Figure 2a & 2b: Y.W. Alex Wong, author's photographs.
Figure 3a, 3b, 3c & 3d: Y.W. Alex Wong, author's photographs.
Figure 4: DoF (Department of Fisheries Malaysia). Data extracted from Annual Fisheries Statistics from 2010-2022. https://www.dof.gov.my/en/resources/fisheries-statistics-i/
Figure 5: Kay, S., Avillanosa, A.L., Cheung, V.V., Dao, H.N., Gonzales, B.J., Palla, H.P., Praptiwi, R.A., Queiros, A,M., Sailley, S.F., Sumeldan, J.D.C., Syazwan, W,M., Then, A.Y.H., & Wee, H.B. (2023). Projected effects of climate change on marine ecosystems in Southeast Asian seas. Front. Mar. Sci. 10:1082170. Doi: 10.3389/fmars.2023.1082170