# UNDERSTANDING LOCAL PERCEPTIONS OF IMPACTS OF CLIMATE CHANGE AMONG SMALL-SCALE SAMA-BAJAU FISHERS AND THEIR PATRONS IN WAKATOBI NATIONAL PARK, INDONESIA

[Received October 8th 2023; accepted March 24th 2024 – DOI: 10.21463/shima.223]

Asnarulkhadi Abu Samah

Universiti Putra Malaysia <asnarulhadi@gmail.com>

Amar Maruf

Universiti Putra Malaysia & Universitas Halu Oleo, Indonesia < amarmaruf@uho.ac.id>

Nobaya Ahmad

Universiti Putra Malaysia <nobaya@upm.edu.my >

Hanina Hamsan

Universiti Putra Malaysia <hanina@upm.edu.my>

**ABSTRACT:** Understanding similarities and differences in perceptions of climate change impacts aids in the development of co-adaptation strategies. While there has been extensive research on perceptions of climate change impacts among small-scale fishing communities, studies focusing on the perspectives of maritime tribes, fishers, and their respective patrons in small islands are notably scarce. The current study compares the perceptions of climate change impacts by Sama-Bajau fishers and their patrons in Wangi-Wangi Island of Wakatobi National Park. Data was collected through in-depth interviews, casual conversations, field observation, and secondary data analysis between August 2021 and February 2022. Findings revealed that although fishers and their patrons similarly perceived some impacts, they perceived others differently because of distinct sources of information and experience. Fishers, middlemen and employees of fishing companies perceived the impacts through personal observation and information from other fishers while government and non-governmental officers relied on scientific reports and personal experience in addition to the information given by the fishers. Future research should explore context-specific coping, adaptation and transformation measures based on local perceptions and diverse patron-client relationships to inform policy development.

**KEYWORDS**: Climate change, patrons, perception, Sama-Bajau Fishers, Wakatobi

## I. Introduction

It has been argued that understanding stakeholders' perceptions of the impacts and risks of climate change is the entry point of climate change mitigation and adaptation. Such understanding can act as a supplement to assess the vulnerability of the communities and regions to climate change in different epistemic frames (Singh et al., 2017). Cochrane et al. (2009) suggested that adaptation plans in the human system need to be locational and contextual. Despite this, local observations interpretations cannot replace scientific understandings of climate change (Byg & Salick, 2009). However, they can be an essential scientific supplement for scientists and policymakers. Consequently, it is necessary to document local perceptions and knowledge and integrate them into adaptation planning for climate change impacts (Aswani et al., 2015).

Previous studies of local perceptions of climate change in small islands have been conducted around the globe with different results and implications. For example, the inhabitants of the Solomon Islands have been challenged by salt intrusion, erosion, sea level rise, floods, cyclones and storm surges, landslides, coral bleaching and food insecurity (Leal et al., 2020). In Papua New Guinea and the Solomon Islands Before, nearly 65,000 people were displaced because of waves and flooding exacerbated by regionally abnormally high sea levels associated with continuing Sea Level Rise (SLR) and El Niño-Southern Oscillation (ENSO) (Hoeke et al., 2013). Meanwhile, Beyerl et al. (2018), surveying Tuvalu, Samoa, and Tonga, demonstrated that contrary to the mainstream perception that sea-level rise is the primary concern, the islanders prioritise drought cyclones and other water-related problems. These findings emphasise self-determination and the critical nature of policies prioritising community perspectives. However, only some studies have examined how marginalised groups, alongside their patrons in the tropical islands, view and react to climate change impacts and risks.

The Sama-Bajau fishers represent one of the most distinctive maritime tribes in the Southeast Asian peninsula that have relied culturally and economically upon coastal resources and marine trades (Kazufumi, 2010). In Southeast Sulawesi, Indonesia, the Bajau are scattered widely over almost all districts and cities, with the Wakatobi district has become one of the most inhabited areas (BPS Wakatobi, 2022). Since the Bajau are known as sea-foraging groups, they are often treated as second-class citizens in the regency. Despite being a minority group in the region, they play an influential role in small-scale fisheries, marine resources and trading (Ariando & Arunotai, 2022).

The Bajau fisher community may face significant challenges due to the potential impacts of climate change. This, in turn, could have implications for the fisheries sector's contribution to the regional economy of Southeast Sulawesi province and domestic fish consumption. Kazufumi's (2010) research findings and data provided by the provincial and district governments (BPS Sulawesi Tenggara, 2021; BPS Wakatobi, 2021) support this assertion. According to these sources, the Sama-Bajau community currently constitutes approximately 34% of the province's fisher population. The number could be higher as Bajau fisherwomen have independently been involved in fishing practices within the Sama-Bajau community. To the fishers, unsuitable conditions for fishing due to climate change doubled with other stressors, such as fish stock declines and ineffective fisheries management, to create more challenges and issues. The prevalence of poverty among the Sama Bajau fishers is also likely to worsen, since fisheries, food security, and poverty reduction are tightly linked (CoC FAO, 2007; Kalikoski et al., 2019).

To sustain their livelihood under socio-environmental changes, some of the Bajau fishers have maintained relationships with patrons such as local middlemen, employees of fishing companies, and government and non-governmental officials. Through these relationships, the fishers gain short-term economic support from middlemen and companies and long-term benefits from better fisheries management and marine conservation from the officials (Asnarul et al., 2023). These relationships may significantly influence how Sama-Bajau fishers perceive and respond to socio-environmental challenges brought about by climate change.

Understanding shared and differing views of climate change impacts among Sama-Bajau fishers and patrons is vital for effective adaptation. Similar perceptions emphasise the need for resilience-based strategies and government policies to sustain fisheries' economic contributions and cultural traditions. Nevertheless, contrasting perspectives highlight the necessity of inclusive and adaptable strategies, considering diverse Sama-Bajau community needs. This underscores the intricate interplay of ecological, economic, and social factors in crafting effective climate change adaptation plans. Therefore, this study delves into the comparative perceptions of climate change impacts between Sama-Bajau fishers and their patrons. It is driven by two investigatory questions. 1) What are the impacts of climate change perceived by the fishers and their patrons. 2) Why do they perceive them differently, in some aspects, while sharing similarities in others?

## II. Perceptions of climate change impacts and risks on small islands

In recent decades, climate change has had widespread impacts on natural and human systems globally. These impacts, resulting from observed climate change, demonstrate the sensitivity of these systems to environmental shifts, regardless of the underlying causes (IPCC, 2014). Continued greenhouse gas emissions will further contribute to warming and long-lasting changes in all climate system components, increasing the likelihood of severe and irreversible effects on people and ecosystems (IPCC, 2014).

Climate change poses significant challenges to fisheries management worldwide, leading to increased ecological, socio-economic, and risk uncertainties for fishers, fish farmers, and fish-dependent communities (Poulain et al., 2018). Coastal areas and small islands, particularly in developing countries like Indonesia, are especially vulnerable to climate change and variability due to their heavy reliance on climate-sensitive resources for livelihoods. These resources already face overexploitation and ecosystem degradation, compounded by limited resources and infrastructure to cope with these changes (De Young et al., 2008; Marshall et al., 2009; Barange et al., 2018).

Climate change impacts small islands and inland regions differently, leading to varying outcomes. Critical climate and oceanic factors affecting small islands encompass changes in air and ocean temperatures, oceanic conditions, rainfall patterns, wind patterns and intensity, sea levels, and wave patterns. Additionally, extreme events like tropical cyclones, droughts, and remote storm surges play a significant role (IPCC, 2014). According to Nurse et al. (2014), potential future risks linked to these factors include reducing adaptive capacity and declining ecosystem services critical for the well-being and livelihoods of small island communities. The extent of impact hinges on factors such as the event's magnitude, frequency, spatial and temporal scope, the island's biophysical characteristics and its social, economic, and political context (IPCC, 2014). Consequently, the impacts, vulnerabilities, and

necessary adaptation measures will vary between island regions and even among countries within the same region (Nurse et al., 2014).

| Observed & Anticipated Impacts & Risks | Sources |
|---|---|
| Risk to water security in almost every small island, increased displacement, economic decline and livelihood failure and loss of lives and assets | IPCC, 2020 |
| Tourism stakeholders in Koh Toh Island, Thailand noted the late arrival of the rainy season, the change of wind and storm directions and intensity, more frequent droughts, warmer air and water temperatures, coral bleaching, species migration, sea level rise and coastal erosion as the impacts of climate change. | Tapsuwan, S., and Rongrongmuang, W, 2015 |
| In the future, rising sea levels will incrementally accelerate the amount and magnitude of erosion. | IPCC, 2014 |
| Nearly 65,000 people were displaced in Papua New Guinea and the Solomon Islands alone as a result of waves and flooding exacerbated by regionally abnormally high sea level associated with continuing SLR and ENSO | Hoeke et al., 2013 |
| The shoreline change on the Hawaiian Islands of Kauai and Maui has historically varied greatly, but persistent erosion has recently prevailed as over 70% of shorelines erosive today | Romine and Fletcher, 2013 |
| The combination of SLR and prolonged northeast winds accelerated erosion on the inhabitable islands of Rosario and Tesoro | Restrepo et al., 2012. |
| As a result of tectonic subsidence and SLR, various Vanuatu communities have been displaced | Ballu et al., 2011 |
| SLR was unlikely to be the primary determining factor in the shoreline changes on 17 islands of Kiribati | Rankey, 2011 |

Table 1 - Climate change impacts and risks on Small Islands and Islanders

## III. Sama-Bajau Fishing Community

Members of this community mainly live on small islands and along the coasts, making their livelihoods from small-scale fisheries and marine trade. Because of the livelihoods, the Sama-Bajau have indigenous ecological knowledge and wisdom to utilise surrounding resources. One example of this intangible human capital is the practice of moving to new fishing grounds once resources begin to decline and return to the fishing ground when the resources seem to be recovering (Pilgrim et al., 2007). They move from one fishing ground to another following the rhythm of coastal waters and the seasonal abundance of fish and non-fish species. As depicted by Tomascik et al. (1997) and Clifton and Majors (2014), this knowledge is related to fish lifecycles, including fish movement, spawning, aggregation, and seasonality. Moreover, before deciding to change their fishing routes, they observe the stars, the wind, the currents, the birds and the coconut trees (Dewiyanti et al., 2019). This example is an indication of the Bajau's adaptive capacity to environmental changes.

In addition to studies about their outstanding indigenous and traditional knowledge and wisdom, other scholars have focused on other aspects of the Sama-Bajau's socio-cultural make-up such as identity, folklore, language, arts, customs and tradition. For instance, Stacey et al. (2018) stated that socialisation into livelihoods and related activities represent a means of maintaining and transmitting their indigenous language over their generations. Additionally, Kazufumi (2012) described how this tribe, previously known as sea-gypsies, migrated from the Malay peninsula to coastal Borneo and the southern Philippines and settled in these areas. Concerning climate change, Stacey et al. (2017) stated that the Bajau, particularly women, are crucial partners in future initiatives to understand, monitor, and address the impacts of climate change on marine food security. In Soropia Waters, Southeast Sulawesi, Indonesia, Bajau fishers observed the increased risk of fishing, reduced fish production, increased fishing costs, the fishing gear's ineffectiveness and the difficulty in determining fishing grounds as some the climate change impacts among their community (Dewiyanti et al., 2019).

## IV. Methodology

A case study was purposively employed in the study with particular regard to its capacity to explore 'how' and 'why' issues (Yin, 2009) in order to describe a phenomenon, problem or behaviour. The research was conducted in Wangi-Wangi Island, the capital of Wakatobi district. This location was selected based on a comprehensive review of secondary data and initial discussions with local experts in small-scale fisheries. The criteria for selecting the case study area encompassed the population of Sama-Bajau fishers, their susceptibility to the impacts and risks of climate change, the expected degree of fishers' participation, accessibility and the presence of multiple patron actors.

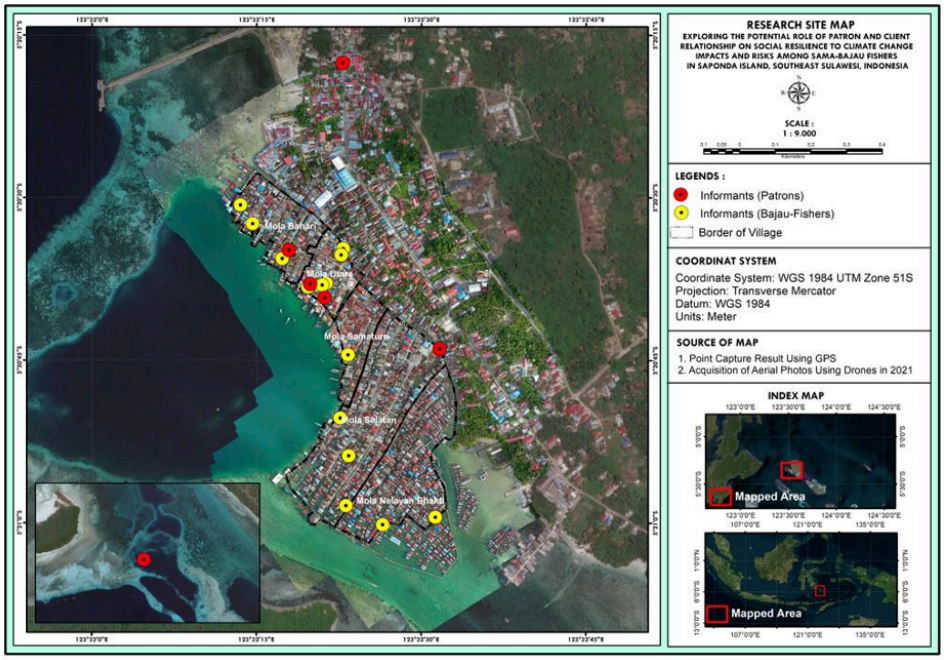


Figure 1 – Map of research area and distribution of study informants.

Situated in the Asia-Pacific World Coral Triangle, Southeast Sulawesi Province, the Wakatobi Islands offer crystal-clear waters and abundant, diverse marine life. The area consists of the four largest islands: Wangi-Wangi, Kaledupa, Tomia, Binongko, and around a hundred small ones. The islands were designated as a marine national park (2002) a year before Wakatobi became a district in 2003, when it separated from Buton district. It was also declared a prospective World Heritage Site in 2005, a UNESCO biosphere reserve in 2012, and an Indonesian Special Economic Zone for Tourism in 2015. Since then, the district government of Wakatobi has made a solid effort to spur regional development by focusing on fisheries, inter-island trade and tourism.

In the fisheries sector, most activities are small-scale marine capture fisheries. Initial discussions with some local experts revealed that climate change has become one of the stressors affecting the fisheries sector. According to DAI (2018), Wakatobi is notably vulnerable to the effects of climate change. The DAI report indicates that the risk associated with climate change will increase over the next 30 years, reducing production in small pelagic fisheries and traditional fishing activities. These risks will directly impact 6,264 fishermen in the district.

In 2021, Sama-Bajau fishers residing in the islands of Wangi-Wangi, Kaledupa, and Tomia accounted for about 46% of the 6,264 total fishermen in Wakatobi (BPS Wakatobi, 2022). However, their number could be higher, as Sama-Bajau fisherwomen were not included in the governmental statistics. After considering time resources and population representation, Wangi-Wangi Island, home to most of the Sama-Bajau population in Wakatobi, was selected as the case study location. Moreover, the most identified patrons are based on the island, as it is also the capital of the Wakatobi district.

The study specifically targeted a subset of the population: small-scale individual fishermen and their respective patrons. The fisher informants met predefined criteria, including engaging primarily in subsistence fishing, making household-level decisions about fishing operations, using traditional fishing equipment, possessing over ten years of fishing experience, having been affected by climate change and maintaining multiple patron relationships. Meanwhile, patron informants are those whom the fisher informants directly mention. The selection of fisher and patron informants followed purposive and snowball sampling techniques. The brainstorming session with local contacts and subsequent interviews with fisher informants were instrumental in identifying individuals (both fishers and patrons) who met the established criteria. This approach aligns with Stake's assertion that sampling involves selecting cases and data sources "that best help us understand the case" (1995, p. 56).

## V. Data Collection

The study began by gathering secondary data from online scientific databases. Additional secondary data were acquired through discussions with local contacts and experts. Meanwhile, primary data were collected through in-depth interviews with fisher and patron informants during fieldwork, using open-ended questions and followed by probing questions, providing general guideline for the face-to-face in-depth interview, while allowing informants to elaborate as necessary. Some questions were included such as:

- Can you describe the impacts of climate change that you have experienced or felt within the last ten years and nowadays?

- Can you describe one instance in detail?
- What were the impacts at different stages of the event (initial impacts during the event – impacts after the event)?
- Do you think past, and current impacts would be the same or different with the future?
- What was the worst impact?

These questions were designed to gather detailed, contextual, and temporal information about the impacts of climate change from the perspectives of the small-scale Sama-Bajau fishers and their patrons. This approach enhances the study by providing a nuanced understanding of the local perceptions and impacts of climate change among fishing communities, thereby contributing to the depth and relevance of the research findings.

Interviews, conducted with the informants' consent, flowed naturally, and they were also invited to suggest other relevant informants. This data collection process continued until no new information emerged. Fourteen fishers and six patrons were interviewed in-depth, along with some other local actors such as village heads and common Sama-Bajau fishers. Additionally, field observations and informal conversations were conducted. Tools like observations, diaries, stationary, village maps, a drone, and a camera were utilised. These methods aimed to capture pertinent information, including evidence of Sea Level Rise. Discussions concerning climate change impacts were held with fishers and local figures in various settings on the island. All information obtained through these methods was cross-referenced with the results of in-depth interviews. Finally, document analysis was employed to complement the primary data. Official documents and reports from various organisations about the study's objectives were consulted to corroborate findings from the field data collection.

## VI. Data Analysis

For this study, initial data analysis was conducted from the inception of the data collection process. All in-depth interviews with fisher and patron informants were recorded, transcribed and subsequently subjected to open coding, coding and theme development. After writing up the interview notes, these notes were approached in a reflexive and critical manner. The transcripts were coded twice, once to organise and another to interpret (Waitt, 2010). A process of thematic coding was used to identify reoccurring themes and ideas within and between interviews (Kitchin & Tate, 2000). The process of coding transcripts and identifying themes was done in a circular manner; first defining a code manually and classifying it into a themed category, then connecting the theme back to the literature.

## VII. Results and discussion

Understanding fisher and patron informants' perceptions of climate change impacts is vital for crafting effective adaptation and mitigation strategies. Both groups of informants concur that climate change has significantly affected the lives and livelihoods of Sama-Bajau fishers. Over the past decade, they have observed discernible signs, including weather and wind pattern shifts and SLR. These changes have immediate implications for their present

circumstances and are anticipated to pose even more significant threats to their future well-being.

### 1. Unpredictable Season and Wind Patterns

Indonesia experiences distinct seasons: rainy (December-February and June-August) and hot, with transitional periods in between. However, in recent years, informants have observed changes in the timing and indicators of each season. These alterations encompass weather patterns, wind directions, transitional periods, and daily wind patterns. The evolving weather patterns are detailed in Table 2 below. The table shows the fisher informants' descriptions of the current and past seasonal patterns observed and fishing calendar during the research. The 'past' category reflects their recollection of seasonal conditions from 10 years ago (2011) as a reference for comparison. Changes have been noted in the length of the dry season, with increased rainfall shifts in precipitation patterns and the transition between wet and dry seasons. Both groups of informants have also noticed changes in prevailing wind seasons, known as West and East winds, which have been shifting monthly and daily. These alterations have significantly affected the fishers' ability to predict wind speed and wave height.

| Weather | Observation Period | Month | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| Wet | Past | | | | | | | | | | | | |
| | Now | | | | | | | | | | | | |
| Dry | Past | | | | | | | | | | | | |
| | Now | | | | | | | | | | | | |
| Transition from Wet to Dry | Past | | | | | | | | | | | | |
| | Now | | | | | | | | | | | | |
| Transition from Dry to Wet | Past | | | | | | | | | | | | |
| | Now | | | | | | | | | | | | |
| Wind | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| Western | Past | | | | | | | | | | | | |
| | Now | | | | | | | | | | | | |
| Eastern | Past | | | | | | | | | | | | |
| | Now | | | | | | | | | | | | |
| Transition | Past | | | | | | | | | | | | |
| | Now | | | | | | | | | | | | |
| *Kapuaka* | Past | | | | | | | | | | | | |
| | Now | | | | | | | | | | | | |
| Fishing Season | Tuna | | | | | | | | | | | | |
| | Reef-Based Fish | | | | | | | | | | | | |

Table 2 - Seasonal & Fishing Calendar of Informants in Wangi-Wangi Island, Wakatobi. (Source: primary data, 2021).

The arrival times of the two wind seasons within a calendar year have also changed, particularly in the past decade. Before 2012, the Western season spanned from October to March, characterised by west, northwest, and southwest winds. Currently, this season occurs

between November and April. The transitional seasons also experienced changes, with the first occurring in March and April and the second extending to months 9 or 10, accompanied by calm days known as *kapuaka* to the Bajau fishers.[1] Although *Kapuaka* still happens, its duration and characteristics have shifted. More information on the uncertainties in seasonal wind patterns, including *kapuaka*, can be found in Table 2.

The fisher informants faced difficulty identifying the beginning and end of Western, Eastern, and transitional wind seasons. Therefore, the information provided in Table 2 can only partially be reliable. However, the table still indicates the uncertainties encountered by the fisher informants regarding wind seasons. Geetha et al. (2015) have observed similar issues fishermen face in Chennai, India, where they need help accurately predicting climate events due to substantial seasonal fluctuations. Marbun (2020) has reported instances where the weather unexpectedly changes from sunny to cloudy or stormy.

## 2. Impacts of Unpredictable Seasonal Weather and Wind Patterns

Based on the data analysed, unpredictable weather and wind patterns have affected fisher informants in four ways: economic disruption, social disruption, health problem, and cultural disruption.

*Economic Disruption*

Economic disruption was mainly caused by reduced fishing time and day, catchability and catch yield leading to increased fishing costs and reduced the earnings. Reduction in fishing time involved decisions such as waiting at home for suitable weather, returning home soon after reaching fishing grounds, or staying at sea during adverse weather conditions. Tuna fisher informants often returned to base before or while fishing during adverse weather due for safety reasons as they operated in open seas. Reef-based fishers, on the other han, took the risks by remaining at sea in shallow reefs waters.

Another factor causing reduction in fishing time and day was changing fishing seasons. The fishing season varies for different target fish, with reef-related fishing occurring from May to November and tuna fishing typically occurring from March to June and September to December (Table 1). However, shifts in weather and wind patterns have hindered fisher informants' ability to optimise their fishing operations during these months. The *kapuaka* season for instance, lasted at least four months in the past, allowing the fishers to maximise their efforts. However, the current *kapuaka*'s period trend (Table 1) has changed and become shorter.

The fisher and patron informants further noticed that strong winds frequently reduce the ability of fishers to catch fish, as the winds altered the current direction, resulting in fish distribution shifts. Fisher #9 argued that "if the wind is strong, the current must be strong as well so that our target fish avoid the area where we are fishing.". Solid winds stirring up sediment in shallow reef waters also made it difficult for the fishers to locate fish.

[1] The term k*apuaka* is used by the Sama Bajau people to describe a period of calm weather in their fishing grounds. During this time, the absence of wind and waves makes for good fishing conditions, resulting in a fruitful catch for the fishermen.

Consequently, limited fishing time, days and catchability contribute to declining fish production. According to Fisher #1 "my fishing time is now reduced compared to before… in the past, the catch was decent because the fishing time was clearer." However, while most fisher informants and middlemen reported a decline in the total catch yield, other patron informants (government and non-government officials) perceived a fluctuating trend rather than a decline as also confirmed by other authors in the Graph 1.

The finding detailed below suggest that perceptions regarding the total catch yield differ among fisher informants, middlemen, and government and non-governmental officers. These differences may stem from variations in the assessment methodologies employed by each group. Government and non-governmental officers rely on quantitative data, collecting information on fish landings daily or per trip from selected fishermen on the island. In contrast, fisher informants and middlemen rely on their recollections and experiences, which may lead to disparities in perceived catch yields.

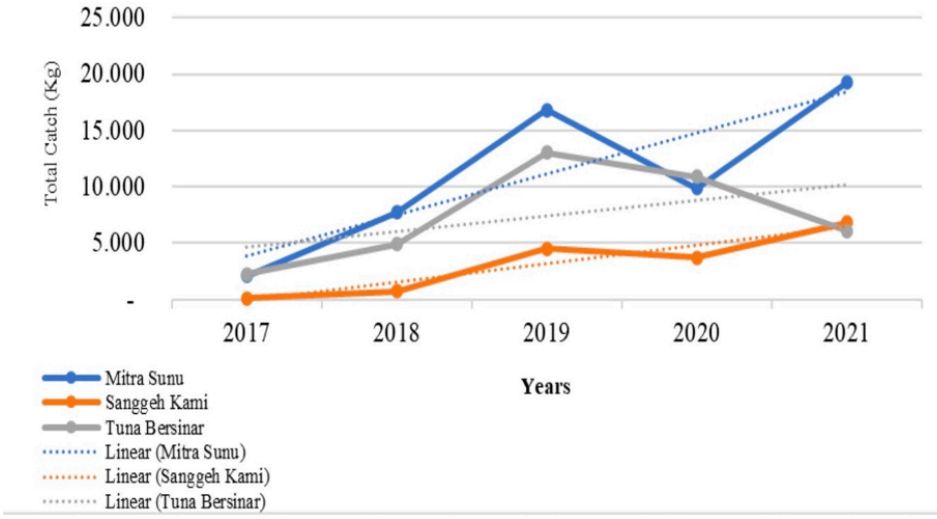


Figure 2 - Production volume trend of three groups of Sama-Bajau fishers in Wangi-Wangi Island (Source: Rowandi and Wardeni, 2022)

The unpredictable weather and wind patterns have also increased fishing costs. Before departure, fisher informants purchased more diesel fuel and ice to prepare for adverse weather conditions or to locate additional fishing spots. At sea, if they opted to return home before reaching the fishing grounds, they should re-purchase diesel fuel, meals, ice, and other necessities for the next fishing day. Opting to stay at sea while waiting for harsh conditions to subside also came with additional costs such as for meals, clean water, cigarettes and ice.

Lastly, the aforementioned impacts of climate change have significantly impacted the earnings of fisher informants and their middlemen. They recognise reduced fishing hours, catch rates, and increased costs as factors affecting income. Fisher #5, for instance, vividly illustrated this:

> *The most profit I can get now is 200 thousand rupiah per trip. But sometimes, nothing or minus. Not only because of the lack of fish, but the weather also affected our efforts. In the past, I could get one million rupiah or more.*

Other studies have also reported similar impacts of climate change on the economic condition of small-scale fishers. In Madagascar, small-scale fishers experienced a significant decrease in available fishing hours over the years due to long-term weather trends affecting wind speed, wave height, and wind direction (Farquhar et al., 2022). Similarly, in Ghana, changes in wind intensity impacted fish catchability, posing threats and uncertainties to small-scale fishers (Mabe & Asase, 2020). Mumby et al. (2014) claimed that adverse weather conditions were noted to temporarily halt fishing activities in the Caribbean and restrict access to specific fishing grounds, affecting the total fish yield. Moreover, in Southeast Sulawesi, climate variability was reported to increase fishing costs for the Sama-Bajau fishers in the Soropia waters of Konawe District (Dewiyanti et al., 2019). In West Africa, climate change impacted income and led to a 50% decline in fisheries-related employment, with annual landed value decreasing by 21% (Lam et al., 2012)

Past and present studies demonstrate that small-scale fishers are highly susceptible to climate variability and unfavourable weather conditions. The influence of weather and climate on fishing practices is not limited to specific geographical regions but poses uniform challenges for small-scale fishers across diverse areas. The cumulative body of evidence highlights the importance of adaptive measures and sustainable management approaches to address the complexities of small-scale fishers' evolving weather patterns and wind conditions. Insights derived from these parallels emphasise the necessity of formulating strategies and interventions to promote sustainability in fisheries. This underscores the pressing need for proactive measures to alleviate the adverse impacts of weather and climate on small-scale fishing endeavours.

*Social Disruption*

Both groups of informants noted additional impacts on Sama-Bajau fishing communities, including heightened debt, increased household discord, mental health, more theft incidents and mutual suspicion. While fisher informants may not have directly experienced these impacts, they acknowledged their potential influence on their lives and livelihoods.

The prevailing sentiment among the fishers was that the unpredictable weather conditions hindered their fishing activities, resulting in reduced income and increased financial strain. Thus, fisher informants revealed instances where their fellow fishers had no choice but to incur debt to meet urgent needs, such as providing food for their families or covering their children's school expenses. Interestingly, despite the difficulties, the fisher informants were committed to avoiding unnecessary debt. Fisher #1 underscored a strategic approach to financial management under a stressor. He and his wife stance vividly illustrated a philosophy wherein borrowing is considered a contingency measure when all other resources have been exhausted. They specifically mentioned how they wish to avoid following the trend observed among other fishermen's wives in their village who frequently borrowed from daily or weekly cooperatives when their husbands could not go out to sea. Their commitment to sidestepping unnecessary debt showcases an equilibrium between preserving financial stability and making do with available resources.

The fisher informants and respective patrons also pointed out tension in many families of fishermen. The situation of debt can escalate to the point of marital dissolution. They detailed instances of wives borrowing from daily or weekly cooperatives without their husbands' knowledge, leading to significant conflict when discovered. They also believed that the increased in income inequality might create social envy, opportunism and conflicts of interest, leading to tension and easing social bonds among the community members. Meanwhile, impacts on mental health were related to financial distress due to the late instalments to the bank and informal money lenders. Although it affected the fisher informants less, they observed that such a situation became concern among their fellow fishers, particularly those who could not make timely debt payments, leading to their houses being under bank surveillance, and verbal abuse and domestic asset seizure from the informal money lenders. This situation reflects the challenges and pressures associated with financial instability, which have implications for the livelihood of the Sama-Bajau fishermen and their families.


Figure 3 - Marked houses of Sama-Bajau fishermen by bank as a sign that the owners could not pay their instalments for several months (authors' photos, 2010-2011).

The next social impact-related to the unpredictable weather and wind patterns was the occurrence of theft. Theft has emerged as an unexpected and indirectly impact of climate change. Adverse weather conditions and declining catches have increased theft incidents among some fishers. Limited income opportunities might drive them to resort to theft to sustain their livelihoods. This trend was concerning as it exacerbated the challenges already faced by fisher informants dealing with adverse climate conditions and dwindling catches. The theft of essential items like diesel, boat propellers, and oars disrupted daily activities and imposed financial burdens, as fishers had to replace the stolen equipment, further straining their resources.

These theft incidents contributed to a sense of insecurity and a decline in the socio-economic stability of the affected Sama-Bajau community. However, the emerging trend of theft among Sama-Bajau fishers did not only contribute to a general sense of insecurity, but also led to safety issues at sea. One of the fisher informants emphasised the perilous nature of having stolen diesel, highlighting a scenario where his engine suddenly stalled during a voyage. Upon investigation, he discovered that his diesel had been partially stolen and replaced with water. This act compromises the integrity and reliability of the engine, posing a direct threat to the fisher's and his boats' safety and navigation capabilities. Moreover, the fisher informants and their patrons faced another issue caused by theft, which has created mutual suspicion among its members. The trust among them has been disrupted due to theft within the community. The fishers were already facing challenges related to changing sea and livelihood, and the possibility of their fellow fishers being the culprits of the thefts has added to their stress. This uncertainty has led to distrust among community members who were once united. Fisher #13 claimed that:

> *As a result, we suspect each other sir, even though we never used to. But I am afraid to accuse, not to be wrong sir. But the suspect is around.*

The increase in theft has caused a shift in the fishing community dynamics, as Fisher #13 expressed concern about accusing someone wrongly. This fear of false accusations has created an atmosphere of suspicion and caution among fishers, who previously had never experienced such mistrust.

Previous studies have shown that climate change affects the financial stability of fishermen, thus leading to indebtedness and tensions although not specifically within the households. Events caused by climate change, such as cyclones and tropical depressions, may contribute to the burden of increasing debt to fishermen and lead them to poverty cycles (Islam et al., 2020). Ahmed et al. (2019) state that in addition to impacting the incomes of fishermen and fish farmers, extreme weather events in Bangladesh have forced fishers to resort to illegal activities to survive. Moreover, despite careful efforts to identify literature that resonates with the area of theft of diesel fuels and propellers, which reduces the safety of small-scale fishermen at sea, some past studies have been found but with different causes. For example, FAO (n.d.) lists engine failure as one of the dangers in fisheries, as well as other causes, such as storms, high waves and wet and slippery seabeds, but does not mention the cause of such failure. This highlights the importance of the current study to illuminate an unresearched aspect of maritime safety in the Sama-Bajau community, in particular the relationship between theft and decreased safety at sea. Trust issues among small-scale fishers have been also studied in previous research, attributing these issues to various causes. For instance, Nulhaqim et al. (2017) discovered that fishermen along the North coast of West Java, Indonesia, experience conflicts over fishing gear with middlemen, consumers, and other stakeholder disputes, leading to decreased trust.

The similarities observed between the present study and prior research highlight the far-reaching effects of climate change on small-scale fishing communities, particularly regarding the financial difficulties leading to conflicts and safety hazards. Tackling these challenges goes beyond geographical boundaries and necessitates customised interventions that acknowledge the diverse hurdles faced by these communities. To sum up, the daily struggles of financial limitations, social tensions, and security issues among small-scale fishing communities underscore these fishers' universal vulnerability to the comprehensive consequences of climate change.

*Physical Health Problems*

In-depth interviews with fishers suggest a connection between climate change and personal health. Climate change has environmental impacts such as high and rough waves and strong winds. Fishers often experience eye irritation from seawater splashes during rough waves, high winds and sun exposure. They have reported impaired vision while fishing and eye irritation for a few days after returning. The eye irritation due to seawater exposure during rough weather was corroborated by the observations of Patron #1. Noting the complaints from most local fishermen, he emphasised how fishers' vision becomes blurred due to frequent exposure to seawater, particularly during periods of turbulent waves. These verbatim responses collectively highlight the consistent and recurrent experience of eye irritation among Sama-Bajau fishers. The combination of splashes from the sea, amplified by more giant waves and the sea breeze, exacerbates the discomfort. This is further intensified by the scorching sun, resulting in painful sensations and diminished visual acuity. Previous research has established a link between seawater splashes, sun exposure, eye irritation, and cataracts. Ahmad (2018) noted that people exposed to the ocean frequently develop allergic conjunctivitis, resulting in ocular irritation and potential complications. Although the specifics differ, the commonality between the present and past studies lies in the ocular irritations experienced due to exposure to the ocean. Both studies underscore the detrimental effects of ocean exposure on eye health, manifesting as various forms of discomfort and impaired vision. These similarities highlight the shared challenges faced by individuals exposed to ocean environments, whether through fishing activities or other engagements with the sea.

Figure 4 - Eye Irritation due to sea water splashes. Photos were taken and are reproduced with the informants' consent (authors' photos).

*Cultural Disruption*

The changing weather patterns have significantly impacted the traditional knowledge of fishing communities. For generations, they relied on their ancestors' knowledge to inform their fishing practices, but this is no longer true. With the transformation in traditional knowledge, particularly about weather monitoring, their means of subsistence have been profoundly affected as they heavily depended on nature. Fisher #4 emphasised that they can only partially rely on the weather forecasting methods of their forebears. While some of their conventional techniques still yielded results occasionally, they were frequently found to need to be more accurate. This corroborates Nurlaili's (2012) research in Sikka, Flores, which underscores that climate change has disrupted the Bajau fishermen's comprehension of environmental conditions, rendering their traditional knowledge inadequate for adapting to these changes. The present and previous studies have highlighted the significant impact of changing weather patterns on fishing communities' traditional knowledge and practices. It is widely observed that there is a diminishing reliance on traditional weather prediction methods, underscoring the pervasive challenges that fishing communities face in adapting to the evolving climate.

## 3. Increased Sea Level Rise (SLR)

While they acknowledge SLR, fisher informants and middlemen have different perception on the impacts of the syndrome than government and non-governmental officers. Both fisher informants and middlemen claimed that SLR has resulted in additional costs as they need to replace the old poles of homes with the new and higher ones to avoid inundation and damages. By contrast, government and non-governmental officers perceived erosion and saltwater intrusion early as impacts of SLR. This is because the two patrons observed the erosion in other parts of the island (outside of Bajau villages) and read preliminary reports of freshwater assessment conducted by another governmental agency.

Figure 5 - A fisher's wife seawater infiltration to inside of her home (authors' photo).

The phenomenon of SLR has also been reported in other ASEAN countries. Sea levels in Thailand have been steadily rising over the past quarter of a century, with a linear trend of about 5 mm/year, as measured by 13 local tide gauge stations installed in the Gulf of Thailand (Sojisuporn, et al., 2013). The current study and previous research findings emphasise the widespread problem of sea-level rise (SLR) problem across ASEAN countries. This carries severe consequences for both coastal communities and infrastructure. Recognising these common challenges underscores the broad influence of SLR throughout the ASEAN region, which affects coastal areas, small islands, and their communities. The collective experience of rising sea levels and its effects on coastal regions highlights the overarching challenge SLR poses.

## VIII. Conclusion and recommendation

The fisher informants and their patrons have noted significant impacts of climate change, including unpredictable weather patterns, wind fluctuations and rising sea levels. These changes have particularly affected the fishing communities regarding reduced fishing time, catchability, increased costs and disrupted traditional weather forecasting methods. Socio-economic consequences such as increased debt, household tensions, mental health issues and theft have also been observed. This study sheds light on an unexplored aspect of maritime safety—the link between theft and reduced safety at sea, adding depth to our understanding of climate change's indirect impacts. Furthermore, there are differing perspectives on the reasons for reduced income and the impacts of sea-level rise. Fisher informants, middlemen, and employees of fishing companies attribute income reduction to decreased fish catch and note an increase in unpaid loans. Conversely, government and non-government officers argue that it is not a reduction in fish catch but a fluctuation. Additionally, while fisher informants highlight property replacement and repair costs due to sea-level rise, their patrons from government and non-governmental organisations are more concerned with erosion and saltwater intrusion.

These varying perceptions stem from differences in how the groups perceive information. The informants, middlemen, and private company employees rely on personal experiences and exchange information within their traditional patron-client relationships. In contrast, government and non-government staff draw from client information and scientific data from their respective offices. As a result, a crucial policy recommendation is to initiate a participative education and communication program, engaging Sama-Bajau fishers and their traditional patrons. This initiative aims to dispel misconceptions about climate change, thus enhancing their coping, adaptive, and transformative capacities towards climate change impacts and potential risks.

**Conflict of Interest**
The authors declare that there is no conflict of interest.

**Funding: The se**cond author wishes to acknowledge the Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA) for funding this study as part of its PhD scholarship to the author.

**Acknowledgments**: The second author wishes to acknowledge Universitas Halu Oleo Kendari for providing the study leave.

## REFERENCES


Ahmad, S. S. (2018). Water related ocular diseases. *Saudi Journal of Ophthalmology*, *32*(3), 227–233.

Ahmed, I., Ayeb-Karlsson, S., van der Geest, K. et al. (2019). Climate change, environmental stress and loss of livelihoods can push people towards illegal activities: a case study from coastal Bangladesh. *Climate and Development, 11*(10), 907-917.

Ariando, W., & Arunotai, N. (2022). The Bajau as a left-behind group in the context of coastal and marine co-management system in Indonesia. *Journal of Marine and Island Cultures,* v11n1, 260-278.

Aswani, S., Vaccaro, I., Abernethy, K. et al. (2015). Can perceptions of environmental and climate change in island communities assist in adaptation planning locally? *Environmental Management, 56*(6), 1487–1501.

Ballu, V., Bouin, M.-N., Siméoni, P., Crawford et al. (2011). Comparing the role of absolute sea-level rise and vertical tectonic motions in coastal flooding, Torres Islands (Vanuatu). *Proceedings of the National Academy of Sciences* 108(32).

Barange, M., Bahri, T., Beveridge, M.C.M., et al. (Eds). (2018). Impacts of climate change on fisheries and aquaculture: Synthesis of current knowledge, adaptation and mitigation options. *FAO Fisheries and Aquaculture Technical Paper* No. 627. Rome, FAO.

Biro Pusat Statistik (BPS) Wakatobi. (2022). *Kecamatan Wangi-Wangi Selatan, Kaledupa dan Tomia dalam angka* 2022. Wakatobi.

Biro Pusat Statistik (BPS) Wakatobi. (2021). *Wakatobi dalam angka 2021*. Badan Pusat Statistik Kabupaten Wakatobi.

BPS Sulawesi Tenggara. (2021). *Sulawesi Tenggara dalam Angka*. Kendari

Beyerl, K., Mieg, H. A., & Weber, E. (2018). Comparing perceived effects of climate-related environmental change and adaptation strategies for the Pacific small island states of Tuvalu, Samoa, and Tonga. *Island Studies Journal*, *13*(1), 25–44.

Byg, A., & Salick, J. (2009). Local perspectives on a global phenomenon—Climate change in Eastern Tibetan villages. *Global Environmental Change, 19*(2), 156–166.

Cochrane, K., De Young, C., Soto, D., & Bahri, T. (Eds). (2009). *Climate change implications for fisheries and aquaculture: Overview of current scientific knowledge*. Food and Agriculture Organization of the United Nations.

Committee on Fisheries (COF). (2007). *Social Issues in Small Scale Fisheries*. Rome, Food and Agriculture Organization of the United Nations.

Clifton, J., & Majors, C. (2014). Culture, conservation, and conflict: Perspectives on marine protection among the Bajau of Southeast Asia. *Society & Natural Resources: An International Journal*, *25*(7), 716-725.

DAI. (2018). *Laporan kajian kerentanan dan resiko iklim propinsi Sulawesi Tenggara*. USAID – Indonesia Office of Environment. https://weadapt.org/placemarks/maps/view/55721/

Dewiyanti, S., Maruf, A., Indriyani, L. (2019). Adaptasi nelayan bajau terhadap dampak perubahan iklim di pesisir Soropia Kabupaten Konawe Sulawesi Tenggara. *Ecogreen* 5(1), 23-29.

De Young, B., Barange, M., Beaugrand, G. & Werner, F. (2008). Regime shifts in marine ecosystems: detection, prediction and management. *Trends in Ecological Evolution, 23*(7): 402–409.

Food and Agriculture Organization of the United Nations. (n.d.). Risk management tools. https://www.fao.org/fishing-safety/risk-management/risk-management-tools/en/

Farquhar, S., Niridrainy, A.F., Heck, N. et al. (2022). The impacts of long-term changes in weather on small-scale fishers' available fishing hours in Nosy Barren, Madagaskar. *Frontiers in Marine Science*, 9:841048.

Geetha, R., Vivekanandan, E., Kizhakudan, J.K., et al. (2015). Indigenous technical knowledge (ITK) of coastal fisherfolk on climate change – a case study in Chennai, South-East Coast of India. *Indian Journal of Fish*, *62*(1): 144-148.

Hoeke, R. K., McInnes, K. L., Kruger, J. Cet al. (2013). Widespread inundation of Pacific islands triggered by distant-source wind-waves. *Global and Planetary Change*, *108*, 128–138.

IPCC. (2014). Summary for policymakers. In Field, C.B., Barros, V.R., Dokken, D.J. et al. (Eds.) *Climate change 2014: Impacts, adaptation, and vulnerability, Part A: Global and sectoral aspects. Contribution of working group II to the 5th assessment report of the intergovernmental panel on climate change* (pp. 1–32). Cambridge: Cambridge University Press.

IPCC (2020). Summary for policymakers. In Pörtner, H.O, Roberts, D.C., E.S.Poloczanska, E. S. et al. (Eds.) *Climate Change 2022: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (pp. 3–33). Cambridge University Press.

Islam, M.M., Islam, N., Habib, A., & Mozumder, M.M.H. (2020). Climate change impacts on a tropical fishery ecosystem: Implications and societal responses. *Sustainability*, 12(19), 7970.

Kalikoski, D.C., Jentoft, S., McConney, P. & Siar, S. (2019). Empowering small-scale fishers to eradicate rural poverty. *Maritime Studies 18***:** 121–125.

Kazufumi, N. (2010). A preliminary spatial data on the distribution of the Sama-Bajau population in Insular Southeast Asia. *Hakusan Review of Anthropology*, 13: 53-62.

Kazufumi, N. (2012). Maritime diaspora and creolization in the Malay Peninsula. In Ikeya, K (Ed.). *Sedentarization among Nomadic Peoples in Asia and Africa*. Senri Ethnological Studies 95. Publication Unit National Museum of Ethnology, Osaka Japan. https://minpaku.repo.nii.ac.jp

Kitchin, R. & Tate, N. (2000). *Conducting research in human geography: Theory, methodology and practice*. Pearson Prentice Hall.

Kelman, I. (2021). Islander migrations and the oceans: From hopes to fears? *Island Studies Journal, 16*(1): 23-42.

Lam, V.W.Y., Cheung, W.W.L., Swartz, W., & Sumaila, U.R. (2012). Climate change impacts on fisheries in West Africa: implications for economic, food and nutritional security. *African Journal of Marine Science, 34*(1), 103-117.

Leal Filho, W., Otoara Ha'apio, M., Lütz, J.M., & Li, C. (2020). Climate change adaptation as a development challenge to small Island states: A case study from the Solomon Islands. *Environmental Science & Policy, 107*, 179–187.

Mabe, F. N., & Asase, A. (2020). Climate change adaptation strategies and fish catchability: The case of inland artisanal fishers along the Volta Basin in Ghana. *Fisheries Research*, 230, 105675.

Marbun, F. (2020). Adaptation strategies of traditional fishermen in Sutera Sub-District, Pesisir Selatan Regency on climate change. *Jurnal Ilmu Sosial Mamangan 8*(1):10-25.

Marshall, N. A., Marshall, P. A., Tamelander, J., et al. (2009). *A framework for social adaptation to climate change: Sustaining tropical coastal communities and Industries*. https://portals.iucn.org/library/efiles/documents/2010-022.pdf

Miñarro S., Forero G, N., Reuter, H., & van Putten, I, E. (2016). The role of patron-client relations on the fishing behaviour of artisanal fishermen in the Spermonde Archipelago (Indonesia). *Marine Policy* 69, 73–83.

Mumby, P., Flower, J., Chollett, I. et al. (2014). *Towards reef resilience and sustainable livelihoods: A handbook for Caribbean coral reef managers*. University of Exeter Press. http://force-project.eu/node/252

Nulhaqim, S. A., Irfan, M., & Adiansah, W. (2017). Konflik pada masyarakat nelayan pantai utara Jawa Barat studi kasus: Di desa eretan wetan Kecamatan Kandanghaur Kabupaten Indramayu. *Riset & PKM*, *4*(1), 11-28.

Nurlaili. (2012). Strategi adaptasi nelayan bajo Menghadapi Perubahan Iklim: Studi nelayan bajo di Kabupaten Sikka, Flores, Nusa Tenggara Timur. *Jurnal Masyarakat dan Budaya*, *14*(3), 599-624.

Nurse, L.A., McLean, R.F., Agard, J. et al. Small islands. In Barros, V.R., Field, C.B, Dokken. D.J. (Eds.) *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 1613-1654). Cambridge University Press.

O'Neill, E, D., Crona, B., Ferrer, A.J.G., & Pomeroy, R. (2019). From typhoons to traders: The role of patron-client relations in mediating fishery responses to natural disasters. *Environmental Research Letter* 14. 045015.

Pilgrim, S.E., Cullen, L.C., Smith, D.J., & Pretty, J. (2007). Hidden harvest or hidden revenue? Local resource use in a remote region of Southeast Sulawesi, Indonesia. *Indian Journal of Traditional Knowledge*, *6*, 150-159.

Poulain, F., Himes-Cornell, A. & Shelton, C. (2018), Methods and tools for climate change adaptation in fisheries and aquaculture, In Barange, M., Bahri, T., Beveridge, M.C.M., et al. (Eds.) *Impacts of climate change on fisheries and aquaculture: Synthesis of current knowledge, adaptation and mitigation options* (pp. 535-566). Food and Agriculture Organization of the United Nations.

Rankey, E.C. (2011). Nature and stability of atoll island shorelines: Gilbert Island chain, Kiribati, Equatorial Pacific. *Sedimentology 58*(7), 1831–1859.

Restrepo, J. C., Otero, L., Casas, A. C., et al. (2012). Shoreline changes between 1954 and 2007 in the marine protected area of the Rosario Island Archipelago (Caribbean of Colombia). *Ocean & Coastal Management, 69, 133–142.*

Romine, B. M., & Fletcher, C. H. (2013). A summary of historical shoreline changes on beaches of Kauai, Oahu, and Maui, Hawaii. *Journal of Coastal Research*, *288*, 605–614.

Rowandi & Sari (2022). Ukuran layak tangkap perikanan karang di perairan Wakatobi dalam mendukung strategi pengelolaan dan pemanfaatan perikanan berkelanjutan pada masyarakat hukum adat saranowali di Wilayah Pulau Binongko, Kabupaten Wakatobi.

Singh, C., Deshpande, T. & Basu, R. (2017). How do we assess vulnerability to climate change in India? A systematic review of literature. *Regional Environmental Change, 17*(2), 527–538.

Sojisuporn, P., Sangmanee, C., & Wattayakorn, G. (2013). Recent estimate of sea-level rise in the Gulf of Thailand. *Maejo International Journal of Science and Technology 7* (Special Issue): 106–113.

Stacey, N., Acciaioli, G., Clifton, J., & Steenbergen, D.J. (2017). Impacts on marine protected areas on livelihoods and food security of the Bajau as an indigenous migratory people in Maritime Southeast Asia. In L. Westlund, A. Charles, S. Garcia & J. Sanders (Eds). *Marine protected areas: Interactions with fishery livelihoods and food security* (pp. 113-126). Food and Agriculture Organisation of the United Nations. http://www.fao.org/policy-support/resources/resources-details/en/c/853709/

Stacey, N., Steenbergen, D.J., Clifton, J. & Acciaioli, G. (2018). Understanding social wellbeing and values of small scale fisheries amongst the Sama-Bajau of Archipelagic

Southeast Asia. In Johnson, D.S. et al. (Eds). *Social wellbeing and the values of small scale fisheries* (pp. 97-123). MARE Publication Series 17

Stake, R. E. (2005). *Qualitative case studies*. In Denzin, N.K. & Lincoln, S. (Eds.) *The Sage Handbook of qualitative research* (3rd ed.) (pp. 443–466). Sage.

Tapsuwan, S., & Rongrongmuang, W. (2015). Climate change perception of the dive tourism industry in Koh Tao island, Thailand. *Journal of Outdoor Recreation and Tourism 11*, 58-63.

Tomascik, T., Mah, A.J., Nontji, A., & Moosa, M.K. (1997). *The ecology of the Indonesian seas: Part II, Vol VIII*. Periplus Editions (HK) Ltd.

Waitt, G. (2010). Doing Foucauldian discourse analysis: Revealing social realities. In Hay, I. (Ed.), *Qualitative methods in Human Geography* (pp. 217-240). Oxford: Oxford University Press.

Yin, R. K. (2009). *Case study research: Design and methods* (5th ed). Sage.