



Artificial coral reefs as a climate measure in Zamboanguita & Dauin

A qualitative research study



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Abstract

This qualitative study investigates ecological, socioeconomic and governance-related factors that need to be accounted for in order for artificial coral reefs to be perceived as successful. The study is conducted through semi-structured interviews with local stakeholders in Zamboanguita and Dauin in the Philippines with non-profit organizations, representatives of the municipality of Zamboanguita, resorts, local fishermen and residents. These interviews were conducted in person and analyzed through a thematic analysis. The material was interpreted through the analytic frameworks of Nature Resource Governance and Climate resilience together with previous research findings. The findings show that AR are mostly connected to tourism-based income but that they are also working as a fish aggregation device that may benefit parts of the local economy and fishing community. However, the benefits are unevenly distributed and depend on local context, stakeholder interest, and different levels of knowledge. Non-governmental organizations (NGO) were more critical of the projects, particularly when economic benefits were prioritized over environmental research and monitoring. A central challenge identified in the study is weak local natural resource governance. Many fishermen do not feel that they are meaningfully included in decisions about the placement and management of shared marine resources. This can reduce legitimacy, trust, and awareness, and may contribute to resistance and conflicts. The study concludes that more environmental research is needed to understand the ecological effects of AR, but also, that improved inclusion, communication and cooperation between stakeholders are essential factors in order for AR to be seen as successful.

Key words: artificial coral reefs, Climate resilience, fishing community, Nature Resource Governance, Zamboanguita, Dauin

Populärvetenskaplig sammanfattning

Klimatförändringarnas effekter utgör ett globalt hot och förlusten av korallrev är särskilt påtaglig i kustsamhällen. I Filippinerna blir denna sårbarhet tydlig där korallreven spelar en central roll för både havets hälsa och mänsklig försörjning. För att hantera hotet om förlorade korallrev, har man skapat artificiella revstrukturer som installeras i haven och har i syfte att med tiden kunna locka koraller, svampar och fiskar. Syftet med denna studien är därmed att undersöka vilka faktorer som spelar in för att nå en upplevd framgång av artificiella revprojekt. Studien visade att de artificiella revprojekt som görs ofta saknar forskning och insamlad data vilket ifrågasätts av de icke-statliga organisationerna. Däremot håller alla aktörer med om att artificiella rev kan producera mer fisk vilket ger fiskarna större chans att få fångst. Dessa vinster är däremot för små för att kunna påstå att projekten leder till långvarig och strukturell förändring för lokalsamhället. En viktig aspekt som belystes var att turismen är en central anledning till varför man bygger artificiella revprojekt, det skapar turistmöjligheter och ekonomiska vinster för de som finansierar åtgärden. Trots att turismen kan skapa vissa jobb möjligheter för lokalbefolkningen, inkluderas sällan fiskare och lokalbefolkningen i dessa projekt. Fiskarsamhällen blir allra mest påverkade av projekten men trots det upplever många att de inte får sin röst hörd. Det verkar även finnas konflikter och motstånd inom vissa fiskarsamhällen vilket kan bero på bristfällig kommunikation och inkludering. Däremot visade studien att aktörerna inte är positiva till artificiella revprojekten om inte lokalsamhället och fiskarsamhällena accepterar insatsen. Fisken inte heller bara viktig för matintag och levebröd utan fisket är större än så, denna traditionella aktivitet är en central del i den lokala kulturen och sociala identiteten. Studien är därmed användbar i att öka förståelsen kring och belysa vikten av att inkludera socioekonomiska aspekter för att nå en upplevd framgång av artificiella korallrevprojekt. Majoriteten av aktörerna vill stärka samarbetet, kommunikationen och deltagandet i ett försök att förbättra tilliten, sammanhållningen och förståelsen för varandras intressen och behov. Därför är både ekologiska faktorer, socioekonomiska/sociala och styrningsrelaterade faktorer centrala för att förstå den upplevda framgången av artificiella korallrevsprojekt.

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1.1 Introduction

Coral reefs are one of the most productive ecosystems on earth and play a central role in maintaining an ecological balance in many marine ecosystems (Naval et.al., 2014 & Ballesteros, 2020). Coral reefs support more than a quarter of all marine life despite covering only 1 % of the seabed (Hilmi et.al, 2025). Coral reefs are contributing to coastal protection, fisheries, biotechnology, cultural heritage, science, and educational opportunities among other things. The coral population in the world is declining at an accelerating rate creating a global threat to the survival of coral reefs (Hein et.al., 2017 & Matorres et.al, 2024). According to one study, 90% of all global coral reefs are threatened with being destroyed by 2030 (Ballesteros, 2020). The cause of the coral destruction is primarily climate change, that includes elevated sea temperatures, extreme weather, ocean acidification and rising sea levels that have accelerated over the past two decades (Boström-Einarsson et.al, 2020 & Matorres et.al., 2024 & Harvey et.al., 2018, 2022 & Awazi, 2025). Other reasons are increased coastal development, pollution, and unsustainable tourism (Hilmi et.al., 2025). The ocean acidification leads to a lower pH in the ocean that decreases carbonate ions, that are crucial for marine organisms like corals to form their shell and skeleton. It also affects the plankton negatively, which affects the whole ecosystem (Awazi, 2025). The sea temperatures due to global warming are alarming because of many reasons. Firstly, it causes coral bleaching due to a breakdown of the symbiotic relationship between corals and algae due to the stress from the increased temperature. On top of that, food fish like tuna and grouper are sensitive to temperature changes, and struggle to reproduce and experience higher mortality rates due to heat. This degradation of coral reefs therefore leads to reduced fish biodiversity and fish populations (Awazi, 2025). Coral reefs are also vital for fishing communities and the local communities, since they provide food security and livelihoods. For communities that rely on fish for protein, live in vulnerable communities where there is increased competition for fish in already crowded regions. This dependency on nature resources that are declining is causing malnutrition and higher poverty and conflict over resources. The decline in fish also disrupts local economies where local consumption and exports create hardship for fishing communities (Awazi, 2025). Therefore, coral reefs are important to human survival where at least 500 million people are dependent on them for food, coastal protection and livelihoods (Hilmi et.al., 2025 & Harvey et.al., 2018).

To address this global threat of degrading coral reefs, marine protected areas (MPA) or “no take zones” are the most common way to protect and to reduce the anthropogenic stressors (Harvey et.al., 2018). On the other hand, artificial reefs (AR) have become increasingly common, where a more active approach is taken instead of a passive. The AR are made of different materials such as concrete, steel or boulders to mimic the natural reefs (Heery et.al., 2018). Structures are places in the sea to provide living space for fish and other marine species and to increase coral cover (Bahinting et.al., 2022). The natural coral reefs have difficulty maintaining a natural recruitment of corals and therefore can artificial recruitment contribute to more resilient reefs and help preserve and restore their structure and function (Boström-Einarsson et.al., 2020). However, careful planning and a smart design is crucial for the AR to be sustainable and efficient (Bahinting, et.al., 2022). AR also need to work in

conjunction with other measures like monitoring of the reefs and less destructive fishing (Bahinting et.al., 2022). Challenges such as illegal fishing activities and tourism are factors that damage coral reefs and affect AR projects (Matorres et.al., 2024). It is therefore not a “cure all” measure for the destructiveness of coral reefs (Bahinting et.al., 2022). There are some criticisms directed at active restoration methods like AR. The critics argue that reforestation of corals does not solve the issue with coral loss, since global warming and effects of climate change continue (Margaux et.al., 2017). It has also been shown that it takes many square meters of coral coverage to even create an ecological effect, which is difficult to achieve due to the high cost of the measure (Mostrales et.al., 2022). Coral reef restoration is approximately 70 times more expensive than coral reef protection (Bahinting et.al., 2022). In addition, critics mean that active coral projects are ineffective in a long-term perspective and that there are only possible short-term benefits (Hein et.al., 2017). Another study emphasizes that the most optimal method is to use a combination of active efforts that can increase biodiversity in the short term and use passive efforts to protect and monitor coral reefs (Boström-Einarsson et.al., 2020 & Horige et.al., 2026). It is also important to highlight that there needs to be a combination of measures that mitigate the anthropogenic effects and measures that increase coral recruitment (Hilmi et.al., 2025). However, the long term ecological, social and economic effects of these projects are still unclear (Horige, et.al, 2026).

In the Philippines, the global threat of coral destruction is noticeably as the country has some of the most biodiverse coral reefs in the world (Horigue et.al., 2026). Both fishing and tourism are two important social values that can create job opportunities and provide increased economic profit to the local community (Hilmi., 2025 & Matorres et.al., 2024). At the same time, the country has many coastal communities, creating an increased vulnerability to the effects of climate change (Awazi, 2025). In the Philippines the destructive fishing methods, sedimentation discharges, tourism and coastal development are the main stressors for the coral reefs (Ballesteros, 2020 & Heery et.al., 2018). One of the biggest challenges for both natural and AR are illegal fishing activities (Matorres et.al., 2024). At the same time, there is a lack of clear policy frameworks and guidelines that regulate these projects. Furthermore, most AR projects are therefore carried out in MPA because of the already existing regulations (Matorres et.al., 2024). Guidelines on how the projects should be carried out, maintained and monitored are lacking, which could lead to weak: cross sectoral coordination, policy integration and reef monitoring (Horige et.al., 2026). An increased governance capacity is therefore needed in parallel to the climate measure (Horige et.al., 2026). In addition, Matorres et.al (2024) emphasizes the importance of analyzing governance and socio-economic aspects to be able to effectively implement, expand, and sustain AR projects. Lastly, Hein et.al (2017) highlights the importance of including socio-economic aspects in the assessment of the effectiveness of AR projects (Hein et.al., 2017). Because of the previous lack of socioeconomic aspects, this study aims to investigate both ecological, socioeconomic and governance related factors that need to be accounted for in regards of AR.

1.2 Aim and research questions

The general aim of the study is to explore factors that need to be accounted for in order for AR to be perceived as successful. More precisely, the study aims to investigate how local stakeholders in Zamboanguita och Dauin perceive artificial coral reef projects, with focus on perceived ecological and socioeconomic effects and the role of local governance, cooperation and social acceptance. This study is guided by these following research questions:

1. What perceived ecological effects do the actors believe the projects have had?
2. What perceived socio-economic effects do the actors believe the projects have had?
3. How do local governance, cooperation and inclusion affect perceptions of project success?

Ecological and socioeconomic perceptions are examined together with local governance, cooperation, and inclusion, since these factors shape how different stakeholders understand and evaluate AR projects.

1.3 Delimitations

The Philippines have been chosen due to their important coral reefs that are placed in the coral triangle, and its coastal communities that are vulnerable to climate stressors (Horigue et.al., 2026 & Awazi, 2025). The study is carried out in Negros Oriental in the Philippines in the city of Zamboanguita and the nearby city of Dauin, where lot of artificial coral reefs have been carried out. The chosen geographic place and the limited time of the study can only represent that specific context, in that specific time. The municipality of Dauin was not included, since they did not have time for an interview. However, the two representatives from the municipality of Zamboanguita were deemed sufficient to represent the municipality in the area. Other delimitations were the exclusion of fragging projects and coral larvae placement due to the scope and timeframe of the study.

2 Analytical frameworks

This chapter presents the analytical concepts used to interpret how local stakeholders perceive the success of AR projects. The framework is based on two connected perspectives: local governance and climate resilience, which are used to analyze how ecological and socio-economic effects are understood differently by the actors.

2.1 Climate resilience

Resilience is used to analyze whether AR are perceived as strengthening ecological and socio-economic capacity to cope with environmental and climate-related pressures or not. The section focuses on ecological resilience, socio-economic resilience, livelihood, food security, adaptive capacity, and vulnerability. This study is based on climate resilience that is defined as the ability of individuals, communities, and ecosystems to anticipate, adapt, and recover from the climate stressors that occur. This can be created through anticipatory strategies, adaptive capacities, and transform vulnerable systems into more robust, sustainable, and equitable ones (Awazi, 2025). Building climate resilience includes capacity-building initiatives, strengthening adaptability and access to resources, knowledge and decision-making power for marginalized communities. It is also vital to encourage community-based solutions and local knowledge on how to adapt to climate stressors (Awazi, 2025). According to Intergovernmental Panel on Climate change (IPCC), regions in Global south is going to suffer the most severe climate impacts with a combination of climate hazards, low adaptive capacity, weak governance, limited access to resources and an even higher poverty. Therefore, building climate resilience in fishing communities is vital for sustaining their food security and livelihoods (Awazi, 2025).

The social aspects need to be included to understand climate resilience because social capital facilitates the human's capacity to absorb, withstand and recover from a crisis. The social capital is defined as a collective group that is built on mutual trust and shared values which can be used as a strategy to build climate resilience (Qamar, 2023, s.142). To increase social capital that is an interconnection of bonding, bridging, and linking between social groups like organizations, institutions and municipalities are vital. More aligned social norms are important factors in traditional practices where there are shared risk, vulnerability, and labor. Shared access to resources among the different social groups could therefore be created through a reinforcement of shared social norms. The understanding of vulnerability is also connected to the “tragedy of the commons”, which explains people's short-term interest in taking care of themselves to survive. The threat of climate change and a decline in fish stock is a real threat to people but due to the need and high dependence on nature resources, people take care of themselves first regardless (Hardin, 1968). However, a sense of belonging and group solidarity can be created when individual members of a community become aware of the difficulties and their collected impact. It motivates people to act directly on a matter and participate collectively when a common context and shared language is established. Therefore, social organization makes it easier for individuals to understand, manage, and recover from climate change events which are vital for marginalized communities (Qamar, 2023).

2.2 Local governance

Local governance is used in this study to analyze how different actors, such as municipalities, NGOs, resorts, fishermen, and residents, participate in and influence AR projects. The section focuses especially on cooperation, inclusion, legitimacy, social acceptance, trust, and conflicts between actors' interests. Cooperation and integration are important between organizations and actors that manage shared marine and coastal related resources. These actors include government agencies, non-governmental organizations (NGO), geographical communities, and user groups. A lack of communication and cooperation between these actors can lead to either inefficiency or conflict on a local level (Bennet & Dearden, 2014). The study is based on Natural Recourse Governance (NRG) that is defined as the interaction between structures, processes and traditions that explain how power and responsibilities are exercised, how decisions are made and how citizens can express their opinions (Bennet & Dearden, 2014, s.99). The NRG is based on legitimacy, transparency, accountability, inclusion, fairness, integration, capability, and adaptability where the central components are cooperation, coordination and consolidation (Bennet & Dearden, 2014). These factors are primarily determined by the power-struggles between stakeholders and the dynamics of inclusion and exclusion of people. Cooperation between independent stakeholders can be difficult because they belong to different social environments. Therefore, the most important factors in organizing communication are common forums where individuals can influence the agreements that are being made.

Furthermore, a level of social capital is central in NRG which means trusting, cooperative, and reciprocal relationships within and between groups (Bennet & Dearden, 2014). To increase social capital these common forums can create trust, build relationships, ease communication, and generate better awareness and knowledge among groups. Furthermore, shared norms and understanding are important, as presented above, and this could be created through information sharing done by municipalities, NGOs and society groups (Bennet & Dearden, 2014). The context of the study aligns with the NRG, since different social groups can be analyzed in terms of how well they communicate with each other based on their interests, trust, and inclusion. A practical example of the NRG is the management and the community acceptance of MPA (MPA). Due to existing legal frameworks, most AR are established within these protected zones, hence their relevance to this study. Apart from the need for clear laws and policies within these areas, one of the most important factors for an effective MPA is the support from the local people, local fishermen and the local community (Bennet & Dearden, 2014).

2.3 Operationalization

In this study, there are three connected dimensions: perceived ecological effects, perceived socio-economic effects, and governance-related conditions. These dimensions guide both the thematic analysis of the interview material and the interpretation of how different stakeholders assess AR projects in Zamboanguita and Dauin. Perceived ecological effects include stakeholders' view on coral growth, fish abundance, biodiversity, material choice, ecological risks, and vulnerability to storms or typhoons. Perceived socio-economic effects include views on food security, livelihoods, fishing opportunities, tourism, job opportunities and possible negative consequences for fishermen and residents. Governance-related conditions include cooperation, inclusion in decision-making, trust, social acceptance, conflicts of interest, and knowledge-sharing.

Together, these dimensions make it possible to analyze artificial reef success as a multidimensional and contested concept. Success is therefore not treated as a fixed or purely technical outcome, but as something shaped by stakeholders' roles, interests, experiences, and knowledge. In the results chapter, these dimensions structure the empirical findings. In the discussion chapter, they are used to assess whether the projects can be understood as successful, for whom they are successful, and under what ecological, socio-economic and governance-related conditions.

3 Methodology

This section describes methodological starting points, site descriptions, and practical implementations. It also includes a methodological discussion and an ethical reflection.

A qualitative method has been applied in this study with the purpose to examine people's experiences and opinions on AR. Through a qualitative method, experiences and perspectives from dive resorts, municipality employees, non-profit organizations, residents and local fishermen can be investigated. The study is based on a case study design where a limited area has been examined in more detail, with several different groups (Bryman, 2018). According to Bryman (2018), a case study is an appropriate approach for investigating a local context, as it enables a more detailed examination of the interaction between social groups. The data collection was conducted with semi-structured interviews, a method that is most frequently used in qualitative research (Bryman, 2018). Lastly, the data collection was analyzed through a thematic analysis based on the analytic framework.

3.1 Semi-structured interviews

In this study, semi-structured interviews were chosen to enable a deeper understanding of the socioeconomic, social and governance related factors. Semi-structured interviews were preferred over unstructured interviews as they provided a balance between flexibility and a

structured framework for the discussion. The use of semi-structured interviews enabled follow-up questions and flexibility in addressing topics raised by respondents, while the interview guide provided sufficient structure to facilitate comparison across interviews (Bryman, 2018). An interview guide was conducted for every chosen group and included several predetermined questions and themes which are shown in Appendix B. Different interview guides were used for each group to tailor the questions to their specific perspectives, while still allowing respondents the flexibility to share experiences and introduce relevant themes that might otherwise have been overlooked by the predefined questions. A test interview was also done to make sure that the interview questions were relevant and clearly formulated.

3.2 Practical implementation

The interview was conducted on site in the Philippines in Zamboanguita and Dauin. The interviews were done in person and were conducted between March 16-April 19. The interviews were recorded and transcribed on Teams to be able to look go through the material again and to effectively manage the data. The audio files were then downloaded to OneDrive and transferred to a USB stick to ensure that the material was stored safely. The automatic transcription was checked manually to correct any errors and a way to get to know the material. The thematic analysis was done in Microsoft Excel, where the data collection was coded through highlighting data points with different colors for different themes. After that, a thematic scheme was done with every group in Microsoft Word. Lastly, a comparison between every separate thematic scheme was conducted to be able to understand all the collected themes and how they interacted with each other.

3.3 Selection

The sample consisted of respondents with different backgrounds and roles to get a broader and more nuanced perspective. The respondents have been categorized into different work categories to analyze their relationships. The categories were: 1) non-profit organizations 2) municipality 3) diving resorts 4) local fishermen and 5) residents. It was two NGOs, two municipality workers, two diving resorts, four local fishermen and two residents, which you see in Table 1. Of the 12 interviews conducted, eight participants were from the Philippines. The distribution was designed to maintain balance between the participants and to provide a more comprehensive overview of different social groups and perspectives. The number of respondents for each group was deemed sufficient for the group to be represented. The respondents had different working titles and backgrounds, but all of them could either describe the practical way of conducting AR, have an opinion, or explain how they are affected by the measure.

NGO	Municipality	Resorts	Fishermen	Residents
Institute of Marine Research (IMR)	Local Disaster Risk Reduction and Management (LDRRMO) worker	Easy diving	Fishermen 1	Local resident 1
Marine Conservation Philippines (MCP)	Coastal risk management (CRM) worker	Thalatta resorts	Fishermen 2	Local resident 2
			Fishermen 3	
			Fishermen 4	

Table 1: Map of respondents

The selection of the organizations, the municipality, and the resorts was based on a goal-oriented selection, in which respondents were chosen according to predefined criteria, to ensure that the sample was relevant to this study's aim (Bryman, 2018). The first criterion was that the actor should work with marine management, research diving, tourism diving, or been involved in constructing or developing AR in the area. The second criterion required that the actor was engaged in or responsible for marine or coastal issues. The last criterion was that the actor should have a local presence and understanding.

Furthermore, the local fishermen were selected differently, with assistance from a contact person at Marine Conservation Philippines (MCP). The contact person selected four representatives of the fishing community from Zamboanguita. Finally, two interns at MCP were interviewed in their free time as residents. The initial mapping of relevant actors has been carried out with the help of one contact person at MCP who suggested contact persons. The area of Zamboanguita was selected because of the number of AR conducted there. Dauin has been selected to be able to include more relevant actors and a bigger selection, in a city where there are also a lot of AR conducted. Both cities are small and therefore was it needed to include two cities to create a bigger selection. Another aspect is that there are established non-profit organizations and resorts working with the protection of coral reefs in both cities, which makes the areas suitable. While the Institute of Marine research (IMR) and Easy diving were located in Dauin, and the remaining actors in Zamboanguita, the study did not aim to compare perspectives between the two areas, rather focus on achieving a balanced representation across the stakeholder groups.

3.4 Site description

This study is conducted in Zamboanguita and Dauin located in southeastern coastline in province Negros Oriental in central of Philippines that is shown in Figure 1. Zamboanguita is a home to 29,569 people (2020) and has 10 local government units. Zamboanguita is a village that attracts people for its veracity of marine life, fostering a culture of fishing and at the same time attracting scuba divers and snorkelers around the world (Municipality of Zamboanguita, n.d.). The fishing tradition arrived long before the Spaniards colonized the

island and contributed to its sense of place and identity. Zamboanguita's economy is therefore largely based on fishing where the fishers contribute to the local economy. The municipality emphasizes sustainable practices and the involvement of the local community to preserve nature and create eco-tourism (Municipality of Zamboanguita, n.d.). Dauin is also a coastal municipality that is also located in the province of Negros Oriental, including 23 barangays and is a home to 30,018 residents (2020) (PhilAtlas, n.d.).

Furthermore, different NGOs are working with contributing to science and monitoring of reefs in the area. One of them is MCP that is placed in Zamboanguita and they are using science to understand how local and global pressures affect marine ecosystems and try to build capacity to reduce and adapt to these pressures. Their prioritized areas are food security, societal stability, and ocean health (MCP, n.d.). IMR that is placed in Dauin and they work with enhancing and developing AR in the area due to vulnerability to climate stressors along the coast (IMR, n.d.). Both NGOs are using scientific methods, like underwater surveys to understand the composition and the health of natural reefs, The difference is that MCP is not engaged in developing AR, unlike IMR.



Figure 1: Map with red marking on Zamboanguita och Dauin.

3.5 Analytical method

The interview material was analyzed through a thematic analysis inspired by Braun and Clarke (2006). The analysis was mainly deductive since several themes were developed from the analytical framework and the research questions. At the same time, the analysis also had inductive elements, where themes were created from the interview material, especially when respondents raised issues that were not fully captured by the initial framework.

In this study, three main analytical dimensions have been used: ecological effects, socio-economic effects, and governance/resilience-related effects. Ecological effects included respondents' perceptions of coral growth, fish abundance, biodiversity, material choice, and vulnerability to storms or typhoons. Socio-economic effects included perceptions of food

security, livelihoods, tourism income, job opportunities, and alternative income. Governance and resilience-related effects included perceptions of cooperation, inclusion, social acceptance, conflict, knowledge-sharing, and adaptive capacity. These dimensions guided the coding process and made it possible to understand important factors and compare how different stakeholder groups viewed the success of AR projects.

The data material was transcribed with the help of Teams and then checked manually to correct any potential errors. The analysis started with repeated readings of the interview transcripts to become familiar with the material. The codes were first grouped according to the main analytical dimensions described above and then developed into themes and sub-themes. Some themes, such as ecological effects, social effects, and socio-economic resilience, were closely connected to the research questions and analytical framework. Other themes, such as interests and conflicts, were developed more inductively from the interview material.

After the initial coding, the themes were compared across stakeholder groups: NGOs, municipality representatives, diving resorts, local fishermen and residents through a thematic map for each group. This comparison was used to identify similarities and differences in how the groups perceived AR and especially how their roles and interests shaped their answers. For example, resorts often discussed AR in relation to tourism, while fishermen focused more on fishing grounds, food security and livelihood. The analysis also considered that respondents based their statements on different forms of knowledge. Some statements were based on scientific monitoring or professional experience, while others were based on personal observation, local experience, or second-hand information from talking to others. This distinction was important when interpreting the material, since the study examines which factors that need to be accounted for the projects to be perceived as successful, rather than measuring the ecological or socio-economic effects directly.

3.6 Methodological discussion

Interviews are a common method in qualitative research. However, some critics believe that the study risks becoming subjective since the researcher chooses what to include and exclude. However, qualitative researchers explain that the assessment is based on both previous research and theoretical ideas (Bryman, 2018). Therefore, the thematic analysis is guided and based on the analytic framework and previous research to minimize potential subjectivity. However, there is always subjectivity in the form of different views of the world, prejudices, and values that shape the interpretation of the importance of different data points.

One limitation is that the study was held in English which was not any of the respondents' first language. This could cause miscommunication and an incorrect result if clarifications are not made. This limitation was handled by simplifying interview questions and asking clarifying questions. An interpreter was also present in two interviews held with the fishermen and therefore, may the wording not fully reflect how the respondent originally expressed it in the translation. The interpreter was also working for the municipality and could potentially be influencing how openly the fishermen felt they could express their views. However, based on the two fishermen's answers, they could express their opinions. The responses from the fishermen who were interviewed without an interpreter were like those who had one, which indicates the interpreter did not have a significant impact on the results.

Furthermore, the study covers only a limited area, during a certain period, with a small number of people. If other respondents were interviewed, the results may differ, since they might have different experiences or knowledge. However, all respondents except for the residents and the fishermen were representing their company, organization or municipality. Therefore, this impact minimizes, since the answers are adapted after what visions, values and interests the company/organization/municipality has. The municipality of Dauin was not interviewed, since they did not have time for the interview and therefore, the municipalities could not be compared. To manage this limitation, two municipality workers in the same municipality were interviewed to conduct a comparison between them. Furthermore, the findings cannot be generalized beyond the specific context of the study; however, they provide valuable insights into the local context, perspective and experiences that are consistent with the purpose of a case study design (Bryman, 2018). Since MCP made suggestions on who to contact, you could argue that there is a risk of distortion for not searching for potential respondents yourself. However, the organization only provided names of actors that they knew were working or building AR and then a secondary mapping was made to ensure that all relevant actors were included.

Furthermore, the stakeholders' different roles and interests could affect how they answer and due to the underlying interest in promoting and developing AR for business, science or job opportunities. In other words, the respondents could have embellished the positive effects or diminished the negative impacts. To address this limitation, critical questions have been asked to these actors to better understand if they are adjusting their answers. However, they could keep information or negative effects that they have seen or experienced for the purpose of promoting the business. To balance this, the critical stakeholders of MCP were chosen to include a stakeholder that has no gain or interest in developing the measure, to get a less colored perspective.

An alternative method to interviews could be participatory observation. The advantages of this method are the deeper understanding of a social reality that is difficult to access through interviews. However, this would not be realistic to carry through in the timeframe that was given. In addition, the study required qualitative answers to specific interview questions

which is not the case in a participatory observation (Bryman, 2018). Semi-structured interviews were therefore considered the most appropriate method for addressing the aims of this study.

Lastly, the chosen analytic method has its advantages as thematic analysis is flexible and a useful tool that gives full, detailed, and complex data (Braun & Clarke, 2006). However, there is no clear general agreement of the methods of approach. Clear and transparent guidelines regarding the implementation are therefore important to not lose the advantages of the thematic analysis. To address this, the course of action has been explained clearly and in detail, which is the recommendation of Braun & Clarke (2006). The analytical framework suggested a structure of the data in the thematic analysis and in that way the findings were analyzed in detail and created full, detailed, and complex data. This was used to make a comparison between stakeholders and to explain a multidimensional context.

3.7 Ethical aspects

The ethical questions that are fundamental are the information requirements, consent, and use requirement (Bryman, 2018). The respondents were informed about the study's purpose and got the chance to ask questions, that participation was voluntary and that they could end it without reason, whenever they wanted. This is important for the interview to be considered ethical and for the respondents to feel comfortable sharing and talking about their experience. In addition, the respondents were informed that the collected data was used for scientific purposes and deleted once the research was done. In an ethical perspective, this aspect is important due to possible sensitive information that could harm or impact respondents negatively. Participants were provided with a consent form to read, after which their verbal consent was recorded to minimize the need for storing signed consent forms in an area where people could reach it. Furthermore, participants remained anonymous throughout the study but consented to the use of information regarding their professional field or job title. The choice to make the people anonymous was to protect the respondents for sensitive information about fishing habits or possible statements that could harm relationships among actors. Lastly, the interviews were done with care and a contextual manner, which is important for the respondents not to experience stress or discomfort.

4 Result and analysis

The results are organized according to the three main dimensions: ecological effects, socio-economic effects, and governance-related factors. The result is based on 12 interviews with different stakeholders in the area and has been analyzed with a thematic analysis. The main themes that were created were “perceived: ecological effects, social effects, socioeconomic resilience and local governance”.

Perceived ecological effects	Perceived social and socioeconomic effects	Local governance
Perceived effect on coral cover	Perceived effect on local community	Cooperation between stakeholders
Perceived effect on fish stocks	Perceived effect on fishing community	Stakeholders' interests
Possible negative ecological effects	Food security and livelihood	Inclusion and participation
Perceived ecological resilience	Social identity	Resistance, conflicts and illegal fishing

Table 2: map of themes and subthemes

4.1 Perceived ecological effects

In this section, perceived ecological effects are presented where perceived effects on coral cover, increased fish stocks, possible negative effects, and perceived climate resilience are sub-themes. Findings based on environmental data from IMR, suggest that AR are increasing coral growth if they are monitored, but primarily works as a fish aggregating device. Examples of different types of artificial reef structures observed during the fieldwork are included in Appendix A

4.1.1 Perceived effect on coral cover

IMR in Dauin claims that their assessment is based on scientific data and states that they have seen an increase in coral growth, where coral colonies have settled on the structures over the years. However, they highlight that science, monitoring and managing of the reefs are necessary for the reef to be successful. The municipality of Zamboanguita and both resorts have also seen an increase in coral growth, and they claim that their AR are covered with corals, sponges and other marine species. One of the resorts describes that:

Our AR, it's full of soft corals, stone corals, everything [...] its 10 meters long, like a tunnel [...] inside it's fully grown with soft corals and sponges.” (Easy diving).

MCP are hesitant to AR due to the lack of science, the minimal coral recruitment and the time aspect. Both municipality workers and MCP argue that the coral growth on an AR takes time. In figure A1 and A2, you can see the difference between a one-year-old and an 18-year-old concrete artificial structure. The Coastal Risk Management worker (CRM) of the municipality states that:

There's much difference between the natural and the artificial, in terms of abundance of coral cover, so it really takes time to establish [...] it really takes time, maybe 10 years, 20 years, or a century (Interview 11).



Figure A1: Concrete AR structure 1 year

Image source: Nova Åström



Figure A2: Concrete AR structure 18 years

Image source: Nova Åström

4.1.2 Perceived effects on fish stocks

Most respondents claim that AR have a positive effect on fish and marine life, since they can work as a fish aggregation device for fishermen. In addition, AR can also work as a home for fish in terms of hiding spots and mating spots, which are important for their reproduction. However, the fishermen argue that it takes time for the AR to produce fish, and that they will not breed and live there immediately. In a long-term perspective, most of the fishermen argue they see an increase in fish stocks, but it is unclear if that effect is due to the AR or the MPAs. One of the fishermen expressed that they have not seen more fish outside an AR.

Furthermore, the Local Disaster Risk Reduction and Management (LDRRMO) worker highlights that AR could never compensate the fish population or fix the fish abundance because of the high fishing pressure. There is also no scientific data on how AR affects fish biomass according to the municipality, they said:

I see good results on fast recovery of coral reef and recruitment of fish to an easier access for marginalized fisherman but there is still no survey conducted regarding fish biomass and coral reef status within these AR (Interview 1).

The perceived positive effect on fish stocks is therefore not confirmed in scientific data but rather an observed and experienced positive effect.

4.1.3 Possible negative ecological effects

Some of the AR projects have created a negative ecological effect according to the NGOs. As shown in figure A3 and A4, tire-based artificial reef structures were visible in both Zamboanguita and Dauin and were described by NGO respondents as problematic. MCP and IMR explain that tires are leaking off chemicals that could disturb balances of nearby coral reefs. There are also other examples where people have put down cars and jeepneys to work as AR that have leaked out chemicals and toxins in the ocean. This can cause imbalances on the natural reefs according to the respondents (MCP). One of the NGO highlights that:

There is a historical shift [...] we're looking at a 20-year history [...] there's been a shift in the usage of materials. Tire reefs are no longer constructed, but concrete and other materials that are better suited for coral recruitment has been used (MCP).

However, MCP argues that as conservationists, they need to weigh the needs of the people versus nature and that it is sometimes fair and reasonable to still choose that despite that it might have a small environmental impact (MCP). In general, the negative ecological effects are not seen to have a significant impact among the NGOs.

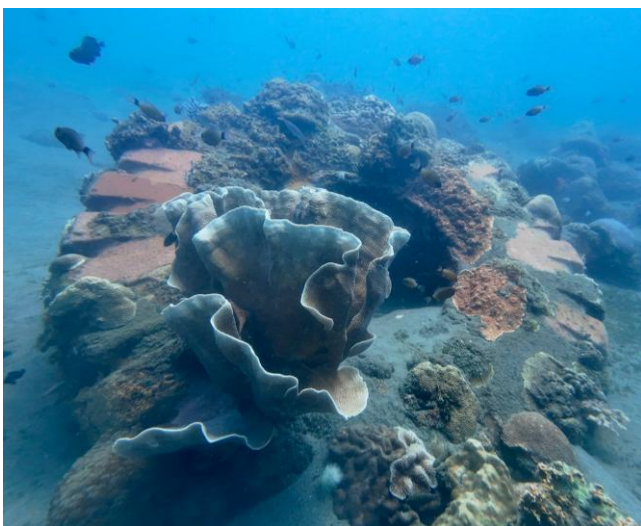


Figure A3: Tire-based AR structure, area 1

Image source: Nova Åström



Figure A4: Tire-based AR structure, area 2

Image source: Nova Åström

4.1.4 Perceived ecological resilience

In terms of climate resilience, AR is not resilient in comparison to natural reefs according to most of the respondents. The AR are perceived as vulnerable for typhoons, storm surges, big waves, high currents and heavy rainfall that is shown in figure 9 in Appendix A. They are also placed too shallow and therefore are the natural reefs more resilient than the AR according to the CRM worker. The CRM worker states that:

I think the natural reef is much more resilient than the artificial, because their establishment is just too shallow. [...] So whenever there's a high current or heavy flow, waves, big waves, and you'll just flip over, very fragile. (Interview 11).

Furthermore, the municipality, MCP and IMR argue that AR has no effect on the recovery or resilience of natural reefs. AR are placed in sandy areas and therefore there is no ecological recovery, IMR says that the “AR create in places where corals wasn't there before, so it doesn't help the natural reefs [...] ecological recovery, none” (IMR).

Several respondents describe visible coral growth and increased marine life. But NGOs and municipal actors also emphasize the lack of scientific monitoring, the slow development of coral growth and the vulnerability of artificial structures to storms, waves and other climate-related pressures. In summary, the findings show that AR are working as a fish aggregation device but are not seen as a long-term climate resilience measure.

4.2 Perceived socioeconomic and social effects

In this section, the perceived socioeconomic and social effects are presented in terms of perceived effects on local community, fish community and how that affect food security and livelihood. This section also presents how job opportunities and alternative incomes are seen as a possible way to strengthen resilience; however, social identities may have an impact on this matter. The findings that are based on personal observation or/and conversations with others suggests that fisherman could carry possible risks and be negatively affected by AR.

4.2.1 Perceived effects on local community

Social sustainability is a priority for the municipality workers, since they argue that the people are directly affected regardless of the project's success. In general, all respondents have observed positive socioeconomic effects of AR projects. Some respondents argue that the projects can create job opportunities and tourism-based income for local community and fishermen. Both resorts argue that they have employees that work with building or monitoring AR. IMR confirms that majority of AR have helped the local community and says, “The local community as a whole I would say the majority of them have helped, [...] There's some bad examples, but there's also some good examples.”

However, MCP expresses that the projects have not affected the local community either negatively or positively, since they are too small to create such an impact. The two residents both expressed that the projects have not hindered or helped them with jobs or income. One of them says, “I don't think it affects my livelihood and job opportunities.” (Respondent 5).

However, tourism-based income is an important factor in the socioeconomic perspective due to its claimed benefits to the local community. MCP states that, “here we're looking at livelihoods, food on the table, basically, kids going to school, increased standard of living for local population.” (MCP). The tourism-based income is often seen as a positive effect among the respondents.

4.2.2 Perceived effects on fishing community

The findings show that the fishing community can be both negatively and positively affected by the establishment of AR in the area. Some of the respondents highlights that the fishermen can lose their fishing nets if it gets tangled up in the artificial reef. With a lost net, the fishermen risk not be able to fish since nets are expensive. All fishermen highlights that it is above their capacity to dive down and retrieve the nets, one of them says, “So, I will not find it, it is too deep, I cannot catch it.” (Respondent 9).

The municipality workers and most of the fishermen, argues that AR established in fishing grounds will create problems for fishermen. One fisherman explains that “the place where we are fishing will become smaller compared to the current situation, definitely the fishing ground will become lesser if more in MPAs will be started.” (Respondent 7).

Despite this, most of the fishermen are positive to the AR since they believe in its claimed benefits to the ocean and to work as a fish aggregating device long term. In addition, two of the fishermen states that the AR is places in the shallow areas and says, “It is not a problem for me because I have another area for fish other than the artificial area.” (Respondent 10).

In addition, there are socioeconomic effects that may affect fishermen in terms of potential job opportunities and alternative income to fishing. The findings show that building and installation of AR together with diving ticket collecting is seen as a potential job opportunity and as a way of alternative income. Tourists need to buy a diving ticket to enter the MPA and 10% of that income goes directly to the diving ticket collector. With AR attracting more divers to the MPAs, it can contribute to more diving tickets and more income for the workers.

4.2.3 Food security and livelihood

Fishermen and residents depend on fish stocks and that become clear when all fishermen and residents express that they themselves and people they know eat fish almost every day. The main diet is fish for many people in this coastal area where people work with selling fish in markets, as shown in figure 5 and 6. Furthermore, the consequence of not getting enough fish would be detrimental according to the locals and the fishermen. The fishermen describe the threat of a decreased fish stock as a threat to the fish cuts, which affects their daily intake. If the fish decreased even more people would starve according to both locals where one of them explains that:

they also have nothing to put on the table anymore, since they're fisherfolk in the Philippines are one of the most marginalized people so their rate of poverty is really high in fisherfolk.

Increased fish stocks are therefore important for the local community, and all fishermen have seen a decrease in fish population. As mentioned earlier, the AR can work as a fish aggregation device and benefit the fisherfolk community. IMR and the municipality of the

respondents are mentioning the spillover effect in relation to AR and MPA. which means that fishermen could catch more fish outside the protected area. As stated before, the fishermen express that it takes a long time for the spillover effect to happen.



Figure A5: fresh fish in Zamboanguita

Image source: Nova Åström



Figure A6: dried fish in Dauin

Image source: Nova Åström

The fish is not only for food intake, but also to sustain people's livelihood. The municipality of Zamboanguita explains that fishermen in the area fish for a living to be able to pay for their children's school. Fishing is a source of livelihood according to all fishermen and all other respondents. One of the locals explain that “fishing really means a lot to me, the fishing sustains my family [...], let me finish university [...] So it was really a big help for me.” (Respondent 5).

Furthermore, one fisherman states that he knows around 100 fishermen that fish in the area and the municipality says that there are more fishermen now than before, due to the job opportunities and the need for income. More fishermen result in a higher demand and a lower fish supply and even if AR could act as a fish aggregating device, the fish is not contributed evenly among the fisherfolks. The respondents (1) said:

Now we have 500 fisher men, we have to understand supply and the demand. One fisher man can have luck and get 6 kilo by himself, well, among the other 10s, that's 4 kilos. It's a good luck of the charm.

The high poverty and the need for fishing result in overfishing, which is one of the biggest problems in the area according to the municipality and the resorts. They argue that the fishermen harvest everything they can from the ocean. However, the fishermen that were

interviewed explained aid that they do not catch juvenile fish if they are alive or endangered species. However, one of the locals says that they have never heard of fisherman freeing any type of fish, because of the high dependence on fish resources.

4.2.4 Social identity

The material suggests that fishing is not only an economic activity, but also part of social identity and cultural belonging in everyday life. One of the locals explains that fishing means a lot, that they grew up in a fisher family where fishing has always been a part of the culture. The other locals explain that they are from the big city of Manila but that after moving to a coastal community, they have seen how integrated fishing is into the culture and the way of living. The respondent (5) expresses that:

Here in Zamboanguita, it's like your means of livelihood [...] So like people living near the coast or normally fishing, fishing folks, it's like a common livelihood [...] it's a part of our culture [...] that's the way of living. (Respondent 5).

The fishermen expressed that they grew up as a fisherman, that the fishing practice have been passed down generations and that they feel happy fishing. A fisherman explains that almost all his relatives do fishing in the fishing community and that they cannot let go of fishing. These findings show that fishing is a part of the culture in the area and that it creates a form of social identity. People want to be a fisherman and to live in a fisherfolk community, respondent 7 says “I cannot let go also that being a fisherman because it makes me happy also. I grew up as a fisherman [...] It gives me peace and relax my mind out of the day.”

In summary, the socio-economic and social effects of AR are perceived as mixed. Some respondents connect the projects to tourism, job opportunities, alternative income, and possible benefits for fish availability. At the same time, fishermen describe risks such as lost fishing nets, reduced access to fishing grounds and uncertainty about who benefits from the projects. The findings also show that fishing is not only an economic activity, but part of social identity, culture, and everyday life.

4.3 Local governance

This section addresses how local governance, cooperation and inclusion are important factors for the perceived success of AR projects by the stakeholders. The findings show that AR are not assessed only through their ecological or economic effects, but also through how decisions are made, who is included, whose interests are prioritized, and whether local communities accept the projects. The section therefore focuses on cooperation between actors, stakeholder interests, inclusion and acceptance, and resistance or conflicts.

4.3.1 Cooperation between stakeholders

The MPA (MPA) are one example of the local governance in Zamboanguita and Dauin, where most AR are placed there to protect them from fishing. The municipality of Zamboanguita is giving clearance on the placement of MPAs together with monitoring and maintaining MPA. However, the municipality describes that even if they wish to create more AR, there is no budget for that, instead private companies finance it. Both resorts are interested in creating more MPAs to protect their AR and therefore want to collaborate with the municipality to negotiate more MPAs. Lastly, IMR explains that the AR have “created new MPA [...] they've also helped enhance MPA in other places.” (IMR). This indicates that the cooperation between the private companies and the management of the MPA is necessary to establish an AR in a protected area.

However, even if AR is located in a protected area, it does not mean that it is fully protected. There are fishermen that is illegally fishing in these areas and are not accepting them as MPAs. One of the municipality worker states that they have apprehended around 100 in one year. There is also co-management in managing these issues between the resorts and the municipality, since they communicate when issues arise. Lastly, one of the resorts thinks that the solution is to implement more policies and to control the area more. There are different opinions in why the fishermen are fishing illegally, but one local highlight that people are not doing illegal fishing because they want to be illegal and says, “we can't blame them also that they just want to be able to fish” (Respondent 6).

This suggests that cooperation between municipalities, resorts and local communities are important factors that need to be accounted for in order for AR projects to be perceived as successful. The projects depend not only on physical placement but also on shared responsibility and communication.

4.3.2 Stakeholders' interests

The municipality is granting AR projects and private companies among others are the ones financing it. All respondents that were asked thought that one of the main incitements for AR is the business and the income it creates. One of the locals says, “There's a lot of money that can be put into it cause it's very nice to sell it, it's a very good for their publicity.” (Respondent 6). This is confirmed with the resorts and Thalatta describes that the guests are marketing the place through social media and that they create big income from AR. Easy diving states that the main goal is to attract more divers and to earn money but also to support the ocean.

The municipality also has an interest in the diving tickets because 30% of its income goes to them. Therefore, the municipality has an incitement to develop the AR and create more income and more jobs for the local community, one of the workers says:

Soon, hopefully, with the right mindset of the management, we are targeting it to be really established there, the artificial reef, because it really creates jobs and it promotes abundance of our marine species. (Respondent 11).

The stakeholders interests are an important factor to account for, since the negative views on lacking science, managing and monitoring of the reefs are a fact in private diving resorts.

4.3.3 Inclusion & participation

It is important to include affected people, to create a higher social capital with social acceptance. Both NGOs are stating that consulting processes with the local fishermen often is inadequate. MCP describes that it is often a meeting where you tell them what the financiers intend to do, rather than encounter for fishermen's opinions. In the contrary, the municipality claim that most of the fishermen are included in AR projects. At the same time the respondent express that the job is between the owner and the municipality and that they give feedback to the fisherfolks when they can. However, in general the municipality expresses that it is their responsibility to include the fishermen and that it will affect their relationship if they keep ignore them, one of the represent said:

The good thing is when we include them on the project, they actually embrace it because they have the sense of ownership. We are the one building it's even if we are paid [...] You know, I am part of, you have the pride, then you protect.

One of the locals and one of the fishermen have experienced that the municipality have gathered people in the community and asked about their opinion. However, most fishermen and the other local resident have not been contacted from the organizations, municipality or the resorts. The fishermen do not feel included, and one said, "no they have not communicated with us, it is between the municipal and the owner [...] I don't feel that I have an opinion." (Respondent 10). The inclusion is important because if there is a lack of understanding and communication, it could lead to resistance. IMR says:

The more the community is involved in every little thing that happens, the more successful project is going be [...] If the community's kept in the dark or not consulted, that's when you can start to get resentment or other kinds of negative feelings.

There seems to be a lack of participation due to a deficiency in communication and inclusion. However, the municipality states that they are aware and take responsibility for the alignment and inclusion of people but highlights that they need more people to engage and participate. The findings suggest that inclusion is a key condition that needs to be accounted for, since projects may be resisted or questioned when affected groups are not genuinely able to influence decisions.

Lastly, there is some communication between resorts and municipality of Zamboanguita, however, this does not necessarily mean that all affected groups are meaningfully included. The findings suggest that when fishermen and residents have limited opportunities to participate or influence decisions, the positive view of AR is reduced.

4.3.4 Resistance, conflicts and illegal fishing

Findings show that there is a social acceptance to AR and MPA establishment within the fisherfolks and locals that were interviewed. Most of them express that the reason is the claimed positive impact on fish availability. However, one fisherman expresses that “I cannot stop it because it is provided by law, but I am OK with it” (Respondent 10). This indicates some sort of hesitation regarding the establishment of AR. Two of the respondents also explained that they have experienced resistance within the fisherfolk community. Social acceptance is therefore important to manage illegal fishing according to the municipality representants. They claim that they are working with community alignment through meetings and consultations (Interview 11). One of them says:

it's of course the support, and understanding that the MPA is not for them, it is the social acceptance in the community, that they accept that this is only my plate (Interview 1).

The findings suggest that inclusion is an important governance-related factor, since projects may be resisted or questioned when affected groups feel informed but are not genuinely able to influence decisions. That resistance has in some fishing groups created conflicts with the resorts, which is seen as one of the biggest problems with establishing AR. Furthermore, Thalatta explain that they have communication with the fishermen through the municipality of Zamboanguita because that is the only thing that works, they said:

This is the permanent fight with the local [...] my goal is to maintain this place, because now is also not only personal, is also business, if I will maintain my business [...] I have to socialize with all the people around this place.

This highlights the will to create better communication, even if the purpose is for business. Another challenge that is highlighted by many respondents is the illegal fishing that exists inside the MPAs since it reduces the protection and the perceived success. An increased resistance together with a lack of acceptance and awareness may lead to a higher risk of illegal fishing.

In summary, the findings show that local governance plays a central role in how artificial reef success is perceived. Cooperation between municipalities, resorts, NGOs and fishing communities can support the projects, but conflicting interests, limited inclusion and weak social acceptance can also undermine their legitimacy. The findings show that trust and social acceptance may be weakened, even when AR projects are described as ecologically or economically beneficial by other actors.

4.4 Summarizing the results

Across all stakeholder groups, views of AR are shaped by ecological outcomes, social dynamics, livelihood conditions, and governance conditions. Perceived ecological outcomes are viewed as positive in terms of aggregating fish and creating new marine habitats, but where coral growth is perceived to be slow with a structure that is seen as vulnerable to weather events. In a social aspect, fishing is viewed to be tied to local and social identity, where fishermen have a sense of belonging and where fishing is part of their culture. However, most of the interviewed fishermen support the measure due to its perceived long-term benefits but some are more hesitant due to lessened fishing grounds.

In a socioeconomic aspect, AR are perceived to generate job opportunities and possible alternative incomes. However, fishermen seem to face risks such as lost nets and reduced fishing areas, which may affect food security and livelihood stability. Governance factors are also shaping the cooperation between municipality, NGO and resorts varies which affect AR projects. Some stakeholders have a better relationship with communications forums and some experience that they are included in decision-making. Others have not been contacted at all and do not feel like they have an opinion, which could explain the indications of mistrust, resistance and conflicts, including illegal fishing in MPAs. Overall, AR are perceived as beneficial to fish aggregation and tourism related income, but in a broader sense the projects are constrained by primarily ecological limitations, socioeconomic risks and lack of inclusion and participation.

5 Discussion

In summary, the most important factors for AR perceived success is: visual coral growth, increased fish availability, job opportunities and alternative income, tourism-based income, inclusion, acceptance and social organization. The local stakeholders in Zamboanguita and Dauin also perceive the success of AR projects differently based on knowledge, interests and experience.

5.1 Ecological factors: coral restoration or fish aggregation?

Firstly, the interviews show that coral growth is perceived as an important factor, but taken together, this assessment is not shared equally across all stakeholder groups. Resorts and municipality representatives describe visible coral growth as a positive sign, while NGOs are more cautious and emphasize the lack of long-term ecological monitoring. Most of the respondents accentuate that it could take decades for the corals to grow on artificial structures. However, the resorts argue that they see a difference in a couple of months. This disputed view can be explained by previous research, where long-term ecological effects are unclear, but where short-term effects of increased biodiversity have been identified (Boström-Einarsson et.al., 2020 & Horige et.al., 2026).

The different perspectives also indicate that the view on ecological factors depends strongly on what kind of knowledge the actor relies on: personal observation, professional experience, or scientific data. In the case of scientific data, IMR states that their monitored AR in Dauin have shown coral growth, but that AR in general have not shown the same results in increasing coral growth. In the case of personal observation, the resorts and representatives of the municipality are claiming increasing coral growth and biodiversity. In the case of professional experience, however, MCP are critical and question the claimed increased coral growth.

In relation to previous research, it suggests that the projects are ineffective in long-term and that the reforestation of corals does not hinder coral degrading or coral loss (Hein et.al., 2017 & Margaux et.al., 2017). This is confirmed in this study, since there are no perceived effects on ecological recovery since the structures are too small to make an impact and are placed in areas where there are no natural coral reefs. Furthermore, the findings suggest that AR are more consistently viewed as positive acting as fish aggregation devices, than as coral restoration measures. Several actors describe that AR creates places where fish can hide, reproduce, and increase in number. However, this does not necessarily mean that the projects restore damaged natural reefs or improve the wider marine ecosystem. This distinction is important because it shows that positive ecological factors can mean different things: for some actors, it means more visible fish, while for others it requires evidence of long-term reef recovery and biodiversity improvement.

The data material also shows that AR can be perceived as negative or even harmful to the ocean when they are poorly planned, placed incorrectly, or made from unsuitable materials. The shift away from tires and other problematic materials indicates that knowledge and practice have changed over time. However, the examples of ecological damage also show that AR are not automatically beneficial. Therefore, are design, material choice, placement, monitoring, and local ecological knowledge important factors to account for in order for the projects to be seen as successful. From a governance perspective, this means that positive ecological effects are closely linked to the quality of planning and regulation. The same conclusion is made in the previous research that argues that careful planning and smart design is crucial for the AR to be sustainable and efficient (Bahinting, et.al., 2022).

In addition, AR are generally not perceived as climate-resilient structures. Most respondents describe them as vulnerable to typhoons, strong currents, storm surges, and heavy rainfall. This challenges the idea of AR as a climate adaptation measure in a strong sense. According to Awazi (2025), climate resilience is when vulnerable systems transform into more robust, sustainable, and equitable ones. However, because of AR vulnerability to climate stressors, they are not perceived to be climate resilient. Instead, they may support fish habitat, tourism or local income but do not increase the ecological resilience of natural reefs in any significant way. Therefore, can AR be understood as a local socio-ecological intervention rather than a robust climate resilience measure.

5.2 Socioeconomic factors: livelihood, food security and tourism benefits

Socioeconomic and social positive factors are primarily perceived by potentially beneficial effects for the local community, especially through tourism, as a fish aggregation device, and in terms of dive ticket income. The material suggests that AR can, to an extent, create job opportunities, increase fish stocks, and create income that could contribute to food security and livelihood stability. Previous research confirms these findings and argues that fishing and tourism are two important social values that create an increased economic profit through created job opportunities (Horige et.al., 2026, Hilmi., 2025 & Matorres et.al., 2024).

In addition, there are also perceived negative social and socioeconomic effects where the projects could create problems for fishermen. Firstly, if fishing grounds are limited, fishermen have less chance of catching fish and to sustain their food intake and livelihood. At the same time, AR can cause fishing gear to become trapped, which can impact fishermen in terms of extra expenses that they do not have. Even if the fishermen that were interviewed were okay with the establishment of the MPAs, there was some that were hesitant and highlighted the importance of access to resources and fishing gear. Therefore, socioeconomic and social effects of the local fishermen and residents are therefore divided with both possible positive and negative outcomes. The findings suggest that small-scale measures alone are not creating a structural socioeconomic change. Previous research states that long-term social, ecological and economic effects are unclear (Horige, et.al, 2026). In this study, it shows AR can be economically successful and at the same time have disputed socially or ecologically benefits.

Further, AR are perceived by most respondents to work as a fish aggregating device. In relation to climate resilience, you could argue that the spill-over effect could create better opportunities to access resources and create a strengthened adaptability (Awazi, 2025). However, this is contested since some fishermen report benefits, and others have not seen the spill-over effect and highlights that it takes a long time for fishes to be reproduced. Another aspect is that there is no survey that can support that AR are the reason for increased fish populations. The AR ability to increase food security and livelihood measures is seen as partial and context dependent.

The findings also show that the fish stocks are not distributed evenly among the fishermen. This can be explained through the tragedy of commons that Hardin (1968) explains in terms of a short-term interest of people taking care of themselves to survive. This means that fishermen get different amount of fish catch, which can be explained through the lack of shared risk, vulnerability and shared access to resources (Qamar, 2023). This is also confirmed in previous research where communities that rely on fish for protein often experience competition for fish in already crowded regions (Awazi, 2025, Hilmi et.al., 2025 & Harvey et.al., 2018). Even if AR could work as a fish aggregating device, findings also show that it can never create a fish abundance due to the high fishing pressure. Therefore, the material suggests that building, installing and monitoring AR, together with diving ticket collecting, could create job opportunities and be an alternative income to fishing. This could be seen as an adapting strategy that strengthens marginalized communities' adaptability and

climate resilience according to Awazi (2025). However, most fishermen do not seem to experience AR as a significant source of alternative income. There was one of the respondents that also worked as a diving ticket collector that had experienced socioeconomic benefits from that alternative income. Apart from that, people do not know anyone that is monitoring and building AR as an alternative income. That confirms that these job opportunities and alternative incomes may not be an option for everyone. The reason for that could be explained by the expressed strong cultural belonging and social identity that exists in fishing, which make people not want to leave fishing behind.

In addition, because of the importance of access to fish resources, positive outcomes cannot only be assessed by asking whether AR produces benefits in general. It also requires asking who benefits, who carries the costs, and whether affected groups are included to have a say in decisions about placement and management. The study shows that the benefits from job opportunities and alternative incomes are limited to individual people and does not necessarily change the broader vulnerability of the fishing community. In other words, the measure may support socio-economic resilience for some actors, but they cannot compensate for broader pressures such as poverty, high fishing dependence, and increasing numbers of fishermen. Therefore, due to the uneven distribution of fish stocks, the perceived effect is context-based and not fairly benefited, where some people benefit more than others. In conclusion, AR projects are perceived to have a limited positive socioeconomic effect. They can contribute to local economic resilience, but mainly through tourism and MPA-related income rather than through broad livelihood transformation. This leaves deeper vulnerabilities unchanged, which connects to previous research of AR not being a “cure all” measure for the destructiveness of coral reefs (Bahinting et.al., 2022).

5.3 Governance and inclusion: why success is contested

The role of interests, governance, cooperation, social capital, inclusion and social acceptance are vital factors to account for in order for AR to be viewed as successful. The clearest reason behind developing AR is perceived to increase tourism opportunities, especially by resorts and partly by the municipality. For the resort, AR could help sustain and develop their business by attracting divers and creating marketing value. For municipalities, they can generate income through diving tickets which can support the local economy. For IMR that invest and finance AR projects, benefit from more divers and an increased income. The findings show that stakeholders that finance AR are benefiting from them the most, through tourism. However, for MCP and fishermen, tourism-based income may be less convincing if it is not connected to fair distribution of benefits, shared knowledge or local participation.

The resorts and the municipality need to cooperate to establish AR, where the resorts are financing the projects and the municipality gives clearance for its establishment. Because of the tourism-based income that benefits both parts, the stakeholders can sustain an effective collaboration. Bennet and Dearden (2014) would explain cooperation as one of the most important factors to an efficient Nature Resource Governance, since it helps to build social capital. The social capital of trust, relationships, communication and shared knowledge could

in turn create better management of shared marine resources (Bennet & Dearden, 2014). The material suggests that cooperation between municipalities, resorts and local communities is central to how AR projects are perceived, because the projects depend not only on physical placement but also on shared responsibility and communication. Bennet & Dearden (2014) explain that the lack of cooperation between social groups is due to separate interests and lack of shared goals, which is the case between the resorts and the fishermen.

The findings can also explain the difficulties cooperating due to a lack of communication, inclusion and social capital between stakeholder groups. Most of the fishermen and residents do not feel included, they do not feel like there is a communication and that they have an opinion on the decisions that are being made. This means that positive social effects cannot only be assessed by asking whether AR produces benefits in general. It also requires asking who benefits, who carries the costs, and whether affected groups have their say in decisions about placement and management. The findings show that most fishermen do not have their say in decisions and that the management is seen to be held between the municipality and the resorts, despite how the projects impact fishermen. However, the findings also suggest that two of the respondents have been included in forums and got to express their opinions, which indicates that the social capital is higher in some social groups. This emphasizes the importance of common forums where all affected groups should be able to have their say and be included in decisions. For an efficient local governance to be established, Bennet & Dearden (2014) describe that there needs to be a social capital where trust is created, relationships are built, and the communication is easier to be able to generate better awareness and knowledge among social groups. The findings suggest that inclusion is a key factor that needs to be accounted for in AR, since projects may be resisted or questioned when affected groups feel informed but not genuinely able to influence decisions.

Further, the feeling of not having an opinion on decisions that affect your daily life can lead to a lack of social acceptance to the establishment of MPAs and AR. The findings show that the lack of social acceptance that could lead to resistance, conflicts and illegal fishing is expressed as the biggest problems with AR projects and MPAs. Even if fishermen that were interviewed accepted the establishments, they expressed that there are people they know that does not have the same acceptance. The social acceptance is important according to previous research where Matorres et.al (2024) state that local people, local fishermen and the local community need to support its establishment for the projects to be effective. However, social acceptance is not simply a question of whether local actors are “for” or “against” AR. It is about how included people feel, how different actors benefit from the measure and how much people understand the purpose of established laws and regulations. Several fishermen express acceptance, but some statements also suggest hesitation, limited influence, or resignation because the projects are connected to laws and MPA regulations that affect their daily lives. This indicates that social acceptance should not be interpreted only as approval, it also depends on understanding, participation, and perceived fairness according to Bennet & Dearden (2014). Even if there is some indication of consultation and communication, it is not enough to create understanding, social acceptance and fairness in equally carried risks. The factor of social and socioeconomic effects of AR is therefore based on who benefits and

carries the risks and how integrated the local people are in the visions, planning and management of their shared resources.

Further, the lack of inclusion and social acceptance of MPAs and AR is linked to increased resistance, conflicts, and illegal fishing in the area. The findings show that illegal fishing is perceived to be negatively affecting AR, which is confirmed in previous research by Bahinting et.al (2022). Both resistance, conflicts, and illegal fishing are viewed as one of the biggest challenges regarding the protection of AR among the stakeholders. Therefore, many of the respondents emphasize the importance of information and knowledge-sharing to the fishermen and residents. However, the lack of shared goals can also explain the frustration and conflicts between the social groups (Bennet & Dearden, 2014). In addition, the material suggests that AR need to work in conjunction with other measures like supporting less destructive fishing and illegal fishing which is confirmed in previous research (Matorres et.al., 2024). The municipality therefore has an important role as a decision-maker and an intermediary between social groups to spread information and awareness to the fishing community. The NGOs also have an part in being an intermediary between social groups but are not engaged in the local governance of AR in the same way that the municipalities are. However, the study has shown that is not only about sharing information and knowledge, but to create trust, understanding of each other's interests and goals to be able to create relationships to increase social capital and social acceptance.

The findings have also shown that there is an experienced sense of ownership when residents or fishermen are included in AR projects. This can be explained by Qamar (2023) that describes that a sense of belonging and a group solidarity can be created when individual members of a community become aware of the difficulties and their collected impact. The findings show that it motivates people to protect the reefs when a common context and shared language is established, which Qamar (2023) calls a strengthen social organization. The level of social organization is therefore perceived as an important social factor since it could determine how included people feel and which common language is shared, which in turn impacts how positive the projects are viewed.

Therefore, is it clear that AR projects are not perceived as planned, designed or integrated enough to be able to create benefits to the local community in a broader and long-term sense. From a governance perspective, the positive outcomes of AR projects therefore depend not only on ecological effects, but also on whether local communities feel informed, involved, and able to influence decisions. The findings in this study also suggest that when cooperation is weak or fishermen feel excluded, the perceived positive socioeconomic effects of the projects is reduced, even if some ecological or economic benefits are visible. Therefore, the study shows that all affected groups need to be included in the management of shared marine resources and that local governance is an important factor that needs to be accounted for in order for the projects to be seen as successful. The material therefore shows that AR is not supposed to be seen as a climate resilience measure, but as a limited local measure where their positive outcomes are dependent on the level of local governance and inclusion. Lastly, the data suggests that AR are perceived to be efficient in terms of the economic benefits for some people, but at the same time there is an ineffective NRG resulting in more critical and

negative view on the projects. Therefore, it shows that the measure can be economically successful and at the same time have disputed socially or ecologically benefits.

5.4 Overall assessment: Created for whom, and under what conditions?

Overall, AR projects in Zamboanguita and Dain are perceived differently by different actors depending on interests, knowledge and experience. In general, AR are planned and designed by companies that have an economic incitement to create tourism-based income and as a secondary goal to benefit the ocean and the local community. Other stakeholders are either benefiting from the projects, having the power to manage them or are affected by them. These different conditions impact how the stakeholders both view and experience AR, where different interests and knowledge shape their opinion. For resorts and the municipality, visible coral growth and increased fish stocks are important ecological factors. For NGOs are the level of science a necessary factor, together with local inclusion and participation of affected social groups for the projects to be perceived as successful. For fisherman and residents, the most important factor is fish availability to sustain their food and livelihood stability. The groups also have different types of knowledge and levels of awareness regarding how AR is supposed to work as a climate measure. Therefore, people that have less knowledge on ecological and social effects on AR may be more shaped by their interests and level of awareness, compared to people with a scientific background. This is confirmed in this study, because the stakeholders that have scientific and local knowledge on ecological and social effects are significantly more critical to the measure than the ones that do not have the same background.

In addition, the assessment is not only based on interests and knowledge but based on how different stakeholders are benefiting from the measure and experience its cause. The socioeconomic benefits are under the condition of uneven benefits, different experiences, and context. This explains why not all fishermen and residents are experiencing benefits and why the resorts are not understanding why people cannot see the positive impact that the measure has. This could be explained by different levels of benefit and different experiences in whether the measures are affecting them positively or negatively. This study therefore suggests that livelihood conditions and the level of benefits shape the groups' view on AR. AR projects is therefore a question of whom the measure is created for, who benefits and under what conditions.

Conclusion

This study shows that there are different dimensions of factors that need to be to account for, in order for AR to be viewed as successful. The ecological factors are mainly connected to their role as fish aggregation devices, while coral growth is perceived as slow, and their contribution to ecological resilience remains limited. Some negative ecological effects were also identified, particularly in relation to unsuitable materials and limited monitoring, which is an important factor to consider. The view of AR projects is shaped by the interaction

between ecological effects and socioeconomic outcomes, social dynamics, resilience, and local governance. Socioeconomic effects are also mixed, where AR may generate job opportunities and alternative incomes, particularly through tourism and diving-related activities. However, these benefits are small, context-dependent and unevenly distributed. Social dynamics are a central aspect that needs to be accounted for in order to AR projects to be seen as successful, since cultural importance and high dependence on fishing shape acceptance of AR and MPAs.

Local governance is also a decisive factor in whether AR projects are legitimate and viewed as successful. Cooperation between municipalities, resorts and NGOs can support AR management, but limited inclusion of fishermen in decision-making can create mistrust, resistance and conflict. However, there is an existing acceptance among some fishermen, but are dependent on whether fishing grounds are being limited. Therefore, the positive long-term social and ecological effects are dependent on governance practices where local governance needs to prioritize transparency, shared responsibility, and community participation. AR projects are perceived as a limited local measure where they are dependent on monitoring, context, governance and, above all, inclusion of affected communities. Without that inclusion, ecological and socioeconomic benefits are perceived to be undermined by social tensions and unequal impacts. The findings therefore suggest that AR should not be understood as a broad climate measure on their own and there are several factors that need to be accounted for. Rather, they may contribute to local benefits when they are implemented with scientific monitoring, transparency, collaboration, and meaningful participation.

Further research

For further research, more interviews with fisher communities are needed to better understand how climate measures are affecting traditional practices like fishing. As stated before, there is a lack of socioeconomic aspects in assessing the possible positive outcomes of AR (Hein et.al., 2017). Therefore, is it important to conduct more studies regarding how people and communities need to adjust and if they are being excluded or included in AR projects. Further investigations need to be conducted on how to effectively: cooperate, coordinate, and consolidate between local stakeholders to increase ecological and social benefits. Furthermore, the negative ecological effects are interesting aspects to investigate further, since that could depend on the AR success.

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Appendix A: Photographs of artificial reef structures

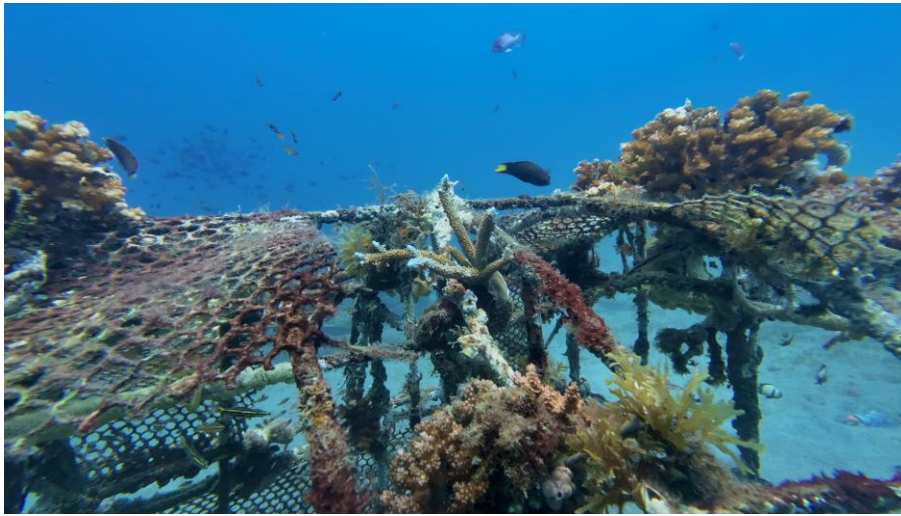


Figure A7: Artificial reef cage structure, one year

Image source: Nova Åström



Figure A8: Artificial structure, one year compared to one day old structure

Image source: Nova Åström



Figure A9: smaller artificial reef cage structure, one year

Image source: Nova Åström



Figure A10: broken concrete artificial reef structure

Image source: Nova Åström

Appendix B

Interview guides

B1 Municipality, dive resorts and organizations

Background & experience

- What got you interested in working with ocean health?
- How many years have you worked with this?

Research purpose and goal

- In your perspective, what are the main goals of the artificial coral reef projects in Zamboanguita or Dauin?
- In what way, if any, do you consider the projects successful?

Ecological effects

- Based on your experience, what ecological changes do you associate with the artificial coral reef projects (like increased coral cover or fish populations)?
- How would you describe AR projects ability to affect the local ecological recovery in Zamboanguita/Dauin?
- Is your assessment based on personal observation, conversation with others, projects reports or something else?

Socioeconomic effects

- Based on your experience, have the projects affected people's opportunities to get food from the sea?
- In your perspective, do you think the projects have created any jobs?
- In your opinion, are the local fishermen included in these projects?
- Based on your experience, have the projects helped or hindered the local community in Zamboanguita /Dauin?
- Is your assessment based on personal observation, conversation with others, projects reports or something else?

Negative

- In your perspective, is there any situation where AR projects can create problems for the local community or local economy?

Possibilities

- Based on your perspective, what are the most important factors for AR to be successful?
- How do you perceive the possibilities for AR to grow and develop in Zamboanguita / Dauin?

Challenges

- In your experience, can you give an example of a challenge you face regarding artificial coral reef projects?

Future & improvements

- Would you say that the artificial coral reef projects in Zamboanguita / Dauin would have to make any improvements? Can you give an example?
- Do you think that these projects are effective and sustainable in the long term?

Other questions

Is there anything else you would like to add, of relevance to this subject?

B2 Local fishermen

Food security

Do you think that fish and seafood is important for people here in Zamboanguita and Dauin and if so, in what way?

Would you say that fishing is a part of Filipino culture and if so in what way?

How many times a week do you eat some sort of fish or seafood?

Do the people you know have fish as their main diet?

Fish stocks and MPA

Have you seen a decrease in fish and sea animals here in Zamboanguita?

Do you see a difference between MPAs and non-MPAs?

Have you been affected by the decrease in fish stocks?

Have you been affected by the establishment of MPAs?

What do you think about artificial coral reefs?

What do you think about the MPAs?

Job opportunities

How many people do you know that work as a fishermen or are selling fish or seafood as a living?

Do you know someone that works with building or monitoring AR?

Would you want to work with building or monitoring AR instead of fishing?

Fishing methods

Are there some fishes that you set free?

What method are you using when you fish, do you use fishing nets or fishing lines?

What is the reason you are using that method?

Do you try to find the fishing nets or fishing lines that you lose when fishing?

Inclusion

What do you think about the AR in Zamboanguita and Dauin?

In what way, if any, do organizations, the municipality or resorts communicate these project plans with you?

Do you feel that you have been included in past AR projects and in the ones planned for the future?

Effect of projects

Have you experienced that there is fish to catch right outside the AR or MPAs where artificial reef exist?

Do AR cause any problems for you?

In your opinion, do AR cause any problems for the local community?

B3 Local residents

Which benefits do coral reefs provide to the local communities in Zamboanguita and Dauin, in your view?

What actions should the local community take to help preserve and protect the coral reefs in your opinion?

Do you have knowledge or awareness on the artificial coral reefs that are being put down in Zamboanguita and Dauin?

Where have you heard about it?

AR projects

What do you think about AR here?

Do you feel like there is any positive effect of AR here in Zamboanguita or Dauin?

Are there any problems with AR in your opinion?

Do you think the companies and organizations that are building artificial coral reefs want to restore reefs and support the local community?

Food security

Do you feel that fishing is a part of your culture and if so, in what way?

How many times a week do you eat some sort of fish or seafood?

Do the people you know have fish as their main diet?

How important would you say fish and seafood are for people here in Zamboanguita and Dauin?

What do you think would happen to the community if more coral reefs are declining and there is a significant decrease in fish stocks?

Job opportunities

How many people do you know that work as a fisherman or are selling fish or seafood as a living?

Do you know someone that works with building or monitoring AR?

Do you think that AR could create jobs for you or someone you know?

Illegal fishing

Have you seen people fish in the MPAs or in areas where AR are?

What do you think is the reason behind fishing in MPAs?

In your experience, do people fish more often using large nets or simple fishing lines?

Inclusion

Have you been asked about the AR projects in Zamboanguita from the municipality, resorts or organizations?

In your opinion, do you think that the municipality is granting AR projects to restore coral reefs and help the local community?