Can Coral Reef Restoration Programmes Facilitate Changes in Environmental Attitudes? A Case Study on a Rural Fisher Community in North Bali, Indonesia

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Abstract

There is currently limited research assessing the ecological potential of coral restoration programmes of habitat enhancement and restoration of benthic and mobile populations for influencing the attitudes (and subsequent behaviours) of the communities where they are based. Our qualitative study investigated the impact of a coral reef restoration programmes on local environmental attitudes in a rural fishing community in north Bali, Indonesia. We conducted semi-structured interviews with individuals and multi-stakeholder focus groups (n = 31) in Tianyar Village, where the NGO 'North Bali Reef Conservation' ('Yowana Bhakti Segara') was based. Our results highlight several factors that influenced environmental behaviours, including perceived value of coral reefs (e.g.,changes in fishing yield), drivers of support for coral reef restoration (e.g., local leaders' influence) and barriers to coral reef restoration support (e.g., lack of investment). Overall, our data indicate that the restoration programme has influenced positive environmental attitudes within the community through improvements in waste management, increased support for restoration work, and the establishment of new environmental regulations. Based on our results, we make five recommendations: (1) continuing environmental education within the community, (2) strengthening regulations and improving enforcement, (3) increasing financial and logistical support for waste management and ecotourism, (4) continuing the construction and deployment of artificial reefs, ensuring 'best practice' recommendations are followed, and (5) utilising the influence of local leaders to create positive environmental behaviours.

Keywords Coral reef restoration · Environmental attitudes · Pro-environmental behaviours (PEB) · Qualitative research · Fisher communities · Tianyar Village · North Bali · Indonesia

Introduction

Coral reefs are critically important to tropical coastlines, providing ecosystem services such as food provision, shoreline protection, biogeochemical cycling, and tourism (Principe et al., 2012; Woodhead et al., 2019) estimated at over US $1 trillion globally (Costanza et al., 2014). However, the health of coral reefs is declining globally at unprecedented rates (Andrello et al., 2021; IPCC, 2021) resulting in losses in associated biodiversity, abundance, and reef structural complexity (Hughes et al., 2018; Pandolfi et al., 2011). Climate change induced coral bleaching is identified as the main reason for coral reef degradation worldwide (Cornwall et al., 2021; IPCC, 2021). Other localised issues such as destructive/over-exploitative fishing techniques (Andrello et al., 2021; Bacalso & Wolff, 2014), nutrient enrichment (Andrello et al., 2021; Lapointe et al., 2019), and pollution (Clukey et al., 2018) pose additional threats to these ecosystems. Heron et al. (2017) estimated that climate-related losses of reef ecosystem services will total approximately US $500 billion by 2100, with the greatest of these impacts experienced by people who rely upon reef services for day-to-day subsistence.

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The bleaching of corals is one of the greatest threats to corals reefs worldwide (Hughes et al., 2017; Sully et al., 2019) indicating the urgent need for an immediate, large-scale reduction in greenhouse gas emissions (Ben-Romdhane et al., 2020). However, small-scale restoration tools may be utilised to capture some of the benefits of ecosystem services from healthy coral reefs to support local communities that depend on them (Hein et al., 2021; Hughes et al., 2023). These include the construction of artificial reefs (Boakes et al., 2022a), establishing propagated coral out-planting projects (Howlett et al., 2022), waste management and environmental education within the community (Sigit et al., 2019), and establishment and enforcement of marine protected areas (MPA) (Pedju, 2018; Zhao et al., 2020).

Ecological 'restoration' has been defined as "the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed" (SER, 2004). However, ecological 'conservation' describes a broader process that includes preservation and protection (Parsons et al., 2017). Our study focuses primarily on tools that actively aim to aid the recovery of previously degraded coral reefs. Consequently, we use the term 'restoration' throughout.

Research indicates that programmes to restore coral reefs increase their overall sustainability and success when they involve local communities (Bennett & Dearden, 2014; Grúňová et al., 2017; Kusumawati & Huang, 2015). Support for marine environment restoration programmes relies heavily on local people's perceptions of personal benefit (Bennett, 2016; Gurney et al., 2014), overall well-being (Diedrich et al., 2017), and /or financial gain (Berkes, 2010).[1] A programme with community support will experience greater engagement from local people (ibid.) that is expected to lead to a general improvement in the community's overall support for protecting the environment (e.g., Liu et al., 2010; Rokicka, 2002), although there is currently limited research among coastal communities.

Education programmes on environmental protection also potentially increase immediate and long-term community support for restoration (dos Santos et al., 2005; Leisher et al., 2012). However, multiple studies have highlighted that an increase in knowledge alone is insufficient for substantial changes to a community's support for coral reef restoration (Brown et al., 2017; Grúňová et al., 2017; Trialfhianty, 2017). Several other factors in engaging local communities in marine restoration programmes: (1) Inclusion of local people in restoration decision-making processes (Lundquist & Granek, 2005) (e.g., compliance with MPA regulations has been shown to be higher when local fishers are involved in their creation (Glaser et al., 2010)); (2) establishing regulations that are clearly understood by local people (Suparno et al., 2019) and ensuring that they are effectively enforced by a respected authority (Doherty et al., 2013); and (3) influence from local leaders has been shown to 'bridge the gap' between local people and marine restoration objectives, and also to promote positive environmental attitudes[2] within the community (Trialfhianty, 2017).

Environmental psychologists have employed various models to gain a deeper understanding of what shapes EAs and thus motivates subsequent PEBs (see Schwartz, 1977; Dunlap & Liere, 1978; Ajzen, 1985; Stern et al., 1999). We identified three constructs emerging from these theories: i) 'Attitude' reflects an individual's or community's perception of engaging in a particular behaviour (e.g., perceived personal financial gain); ii) 'Subjective Norm' refers to the belief that other individuals or groups will approve or disapprove of a given behaviour (e.g., influence from local leaders (Ajzen, 1985)); iii) 'Perceived Behavioural Control' reflects the perceived difficulty of enacting a given behaviour, and is based on relevant factors that may facilitate or impede it (e.g., lack of investment). It is expected that individuals with differing levels of these three theoretical constructs will systematically differ in their EAs and PEBs (Aral & López-Sintas, 2023).

Our aim was to investigate if and how a coral reef restoration programme in Tianyar Village, north Bali, had facilitated changes in environmental attitudes and behaviours within the local community through qualitative research. More specifically, we were interested in understanding the attitudes, subjective norms, and perceived behavioural control that influenced a community's support for their local coral reef restoration programme (Bennett & Dearden,

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[1] For example, a fisher increasing yield due to higher fish biomass as a result of 'the spill-over effect' from a marine protected area (MPA) (Di Lorenzo et al., 2020; Lenihan et al., 2021), or an increase in tourism related jobs (Mangubhai et al., 2020).
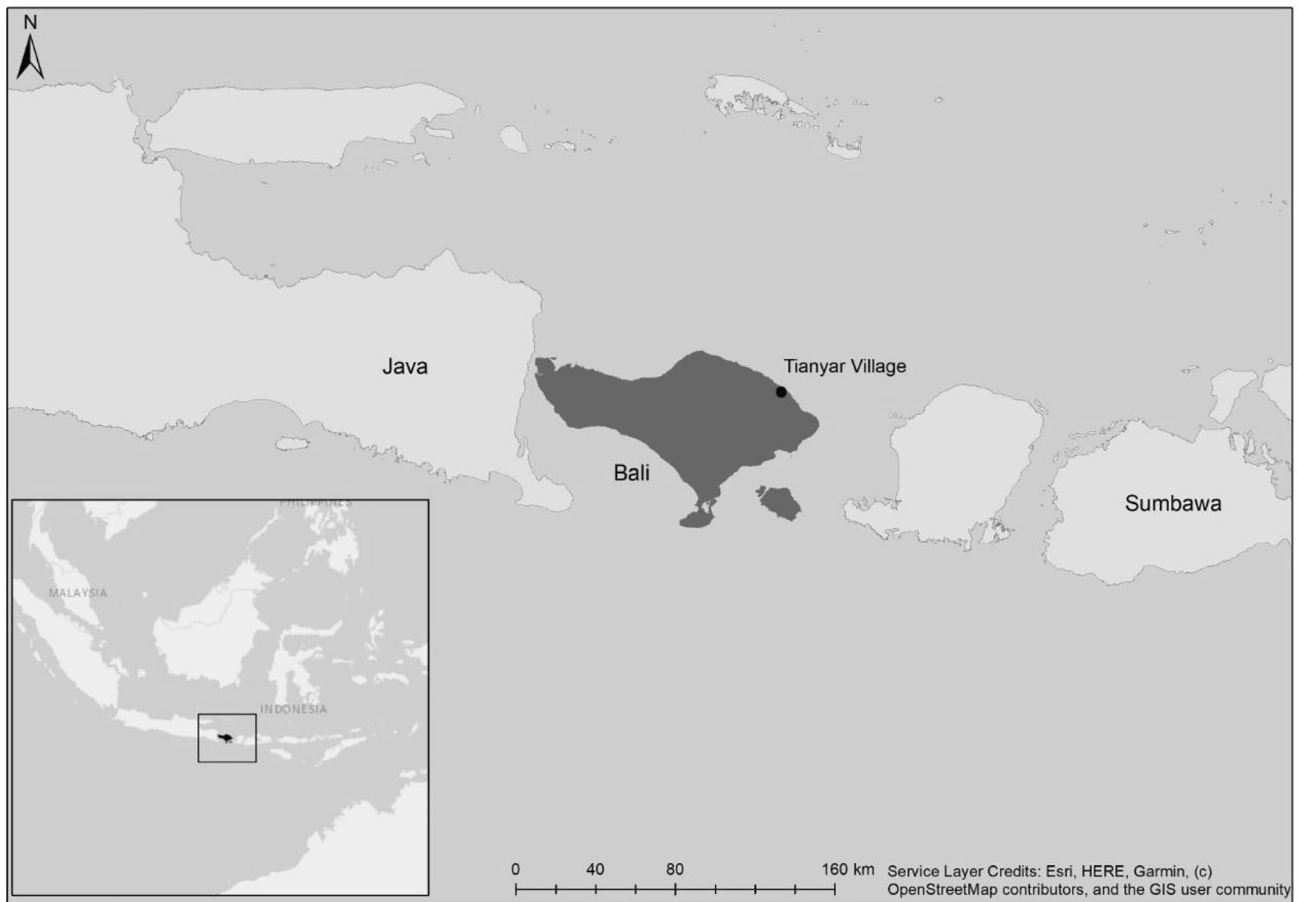
[2] Environmental attitudes (EAs) are important in the field of environmental conservation and restoration because they often determine behaviours (of an individual or a community) that can impact environmental quality (Gifford & Sussman 2012; Milfont 2007). Individuals' attitudes are formed from their experiences, social factors, and observational learning (Cherry 2018), and their internal and stable responses to objects, ideas, or people are reflected in their EAs. These can be specific to behaviours, such as perceived behavioural importance, or based on value orientations, such as ecocentrism (Naiman et al., 2023). Eas are strong positive predictors of pro-environmental behaviours (PEB) (Ertz & Sarigöllü 2019), which can be defined as all possible actions aimed at reducing threats to and/or safeguarding the environment (Steg & Vlek 2009). Hofman et al. (2020) created a list of 34 PEBs that can be undertaken by individuals to protect the marine environment, including reducing /refusing plastics, following good diving / snorkelling etiquette, and volunteering time to support environmental causes. The social landscape of a community strongly influences individuals' EAs (Mainzer & Luloff 2017), which in some cases, can lead to poorly informed behaviours that are damaging to the environment (Moran 2016).

Fig. 1 Location of Tianyar Village and Bali within Indonesia. *(Created using ArcGIS OpenStreetMap powered by Esri)*

2014; Grúňová et al., 2017; Kusumawati & Huang, 2015). Research on EAs of coastal communities is limited and inconclusive in Bali and wider Indonesia. However, it has been shown that environmental issues Indonesia could be greatly reduced through PEBs (see Ulhasanah & Goto, 2018; Adam et al., 2021). Our research is especially pertinent because it engages with the opinions of generally underrepresented communities in a low-middle income nation to gather data for a unique set of recommendations for improving coral reef restoration in other parts of the world.

We conducted our qualitative research in Bali, an island province of Indonesia during July and August 2021 (Fig. 1). Indonesia is a low-middle income country (Sujarwoto et al., 2018) and contains 12.5% of the world's total coral reef area (Susiloningtyas et al., 2018). Bali has the second highest documented reef fish species richness in the Asia–Pacific. Data from 2017 indicated that 50% of Bali's corals are in good health, while 20% are declining, and 30% are poor (Marine and Fisheries Office 2017 data, as cited in Wicaksana, 2020). The primary reasons for the decline are associated with climate change (Prasetia et al., 2017; Suparno et al., 2019; Tito et al., 2019), destructive fishing practices

(Doherty et al., 2013; Frey & Berkes, 2014) and marine pollution (Germanov et al., 2019; Suteja et al., 2021).

Methods

Study Site

Following a decline in coral health in recent decades, the active restoration of Indonesia's reefs has been initiated by community groups, international NGOs, and the government (both on a local and central scale). The most notable restoration tools employed include the establishment of three MPAs (Pedju, 2018), deployment of artificial reefs as habitat enhancement tools on many degraded reefs (Wicaksana, 2020; Boakes, Hall, Ampou et al., 2022a), and the development of ecotourism destinations that promote coral reef restoration (Trialfhianty, 2017). Sustainability-related programmes, specifically in Bali, have been shown to obtain greater support from the wider community when the initial ideas are discussed at community meetings (*desa adat*) (Table 3 glossary) *(*Trialfhianty, 2017; Wardana, 2019; Yunitawati & Clifton, 2019).

We collected qualitative data in Tianyar Village in Bali's Karangasem regency, where primary occupations are fishing and selling fish (De Brauwer et al., 2017). The 3 km coastline includes a natural coral reef considered healthy ($> 40\%$ coral cover, $\geq 3,480$ g/100m² herbivorous fish biomass and $\geq 1,680$ g/100m² commercial fish biomass (Díaz-Pérez et al., 2016)) as well as an empty, degraded area ($< 5\%$ coral cover, < 960 g/100m² herbivorous fish biomass and ≥ 420 g/100m² commercial fish biomass (Díaz-Pérez et al., 2016)), where reefs were destroyed by unsustainable fishing techniques and boat anchoring (personal communications). Tianyar village attracts relatively few tourists, especially in comparison to the mass tourism areas in the south of the island.

The coral reef restoration non-government organisation (NGO) 'North Bali Reef Conservation' (locally known as 'Yowana Bhakti Segara') was based in the village at the time of data collection. Established in 2017, NGO was well-known for its community coral reef restoration efforts, notably the deployment of approximately 15,000 artificial reef (AR) structures (1 m $\times$ 0.5 m) in areas of previously destroyed reef. Its work is funded by ongoing international donations and occasional government grants, and (at the time of data collection) was the only organisation of its kind in the local area. Its ARs are located inside a no-take-zone MPA established and regulated by the local community, which was familiar with foreign-assisted coral restoration projects and was involved in the establishment of environmental targets, as well as providing scientific and logistical support (personal communication). In an earlier study (Boakes, Hall, Jones et al., 2022b) we described the work of this community in successfully restoring an area of reef in North Bali to its earlier level of marine biodiversity similar to a nearby healthy natural reef. Based on this previous research, we were able to assess how the EAs of the community in Tianyar Village have changed as a result of the restoration programme. Social research is rarely undertaken in the region, especially in area of EAs in coastal communities, allowing new insights for local governing bodies and marine management authorities (see also e.g., Bennett & Dearden, 2014; Kusumawati & Huang, 2015; Grúňová et al., 2017).

Interviews and Focus Group Discussions

Between July–August 2021 we conducted both semi-structured interviews and multi-stakeholder focus group discussions with 31 participants. Following Gelcich et al. (2009), we conducted 11 in-depth, semi-structured interviews with key informants of groups from a cross section of the community, including community leaders (from the local government, educational institutions, businesses and religious groups), fishers, fishmongers, tourism workers, and school students. Additionally, following Legare et al. (2020), we conducted two multi-stakeholder fisher focus group discussions each of 10 participants, which allowed us to assess if individual opinions differed in a group rather than face-to-fact context (Kellmereit, 2015).

Participants for both interviews and focus groups were selected purposefully aided by a village leader familiar with the community, based on our perceptions of how a participant might enhance our understanding of how coral reef restoration activities had influenced environmental attitudes in the community (Creswell & Creswell, 2017; Kuper et al., 2008). Participants were selected based on the nature of their employment (e.g., fishers), perspective (whether for and against coral reef restoration – as advised by members of the community), and/or social diversity (e.g., age, gender, and educational background). Chosen participants were initially approached (either via a phone call or in-person) and asked if they were willing to participate in our study (Kruglov & Davidson, 1953). Out of the 32 people we approached, one declined. Participants were given written information about our research goals and methods and Bournemouth University's ethical review process (reference number: 37431), and asked to indicate their consent to participate in the project. Following Wager and Williams (2013), to reduce bias in the interviews, we further explained that their names and responses would remain anonymous and be allocated a code (e.g., interviewee 1 = I1 / focus group 1 = FG1) to ensure anonymity. The interviews and focus groups were conducted in a variety of locations according to the preference and availability of the interviewee. In the instances where participants expressed no preference, interviews were conducted in a private meeting room. The interviews were conducted in a mixture of Indonesian and Balinese by a local researcher fluent in both languages.

The Theory of Planne Behaviour (TPB) was used as a framework to categorise key topics emerging from the interview responses (Kumar Chaudhary et al., 2017; Steg and de Groot (2018). Based on the literature (and our understanding of the topic and case study at the time), our framework identified three main factors that affected attitudes and behaviours towards coral restoration, which we used to design our interview and focus group questions (Table 1).

Interviews and focus groups were recorded on a SONY ICD -UX533F recorder, and initiated with general questions or conversation topics such as "Tell me about your typical day," and then proceeded to topics related to food, work, or the marine environment (Grimm & Needham, 2012; Patton, 2014) before addressing more specific topics (Table 1). Not all questions were asked in every interview, but chosen

Table 1 Factors affecting attitudes towards coral restoration and associated interview questions

Key factor	Associated interview questions	Relevant literature
Perceived value of coral reefs	• *Do you think there a link between coral reef conservation and ecotourism development? And if so, please explain* • *Has you experienced increases in fishing yield as a result of the coral reef conservation program? And [if yes or no], why do you think this is?*	Schwartz (1992, 2012) Choi and Lee (2012) Woo and Kim (2019) Kim et al. (2020) Rizzi et al. (2020)
Drivers of support for coral reef restoration	• *Who are the people leading coral reef conservation here? What have these people done to engage the community in the project?* • *What makes people want to support coral reef conservation here?* • *How do you find out information and/or news about coral reef conservation?*	Hungerford and Volk (1990), Diedrich (2007) Berkes (2010) Bennett and Dearden (2014) McLeod and Palmer (2015) Bakari et al. (2017) Grúňová et al. (2017) Trialfhianty (2017) Rizzi et al. (2020)
Barriers to coral reef restoration support	• *What is needed to develop coral reef conservation community support here?* • *What are the reasons people here may choose to not support coral reef conservation?*	Steg and Vlek (2009) Doherty et al. (2013) Kostić and Petrović (2013), Nordfjærn et al. (2014) Mahyuni (2016) Suparno et al. (2019)

according to the interviewee's background (e.g., only fishers or fish sellers were asked about fishing yield).[3] Focus group discussions lasted between 1–2 h, and all interviews lasted between 30 min to 2 h.

Sample Size and Characteristics

Justification of sample size often depends on the research topic, quality of data, cultural factors, and interviewees' responses (Marshall et al., 2013; Morse, 2000; Patton, 2014). Mason (2010) reported that, from 560 studies, the mean sample size was 31, and Marshall et al. (2013) suggested that single case studies should include 15 to 30 interviews. However, qualitative researchers generally agree that rather than predetermining a sample size, it is more useful to finish at a given degree of saturation (Moura et al., 2021). 'Saturation' refers to the point at which additional interviews no longer offer new insights and information about the given topic (Charmaz, 2006; Dworkin, 2012). Following Moura et al. (2021), we decided that when we reached saturation we would interview two more participants. We reached this point after 31 interviews (11 one–one interviews, and two focus groups each with 10 people). Due to the similarity of responses between focus

groups and individuals, we also decided that findings in the results section would be presented jointly.

Additionally, finding female participants willing to be interviewed proved problematic (see Table 2). However, we were able to recruit female respondents from a wide range of occupational and social groups (e.g., fish sellers, education workers, students, tourism workers). Interviews with female respondents were discontinued after it was clear that we had recorded a wide variety of their opinions from a broad range of groups.

Table 2 Summary table of respondents' sociodemographic characteristics, highlighting the percentage of respondents within a given group

Gender		Occupation	
Female	27%	Government and policy	18%
Male	73%	Education	9%
Prefer not to say	0%	Tourism	18%
Age Group		Fishing / selling fish	36%
16–24	9%	Non-government organisation	9%
25–34	18%	Student	9%
35–44	36%	**Highest Level of Education**	
45–54	27%	Elementary school	36%
55–64	9%	Middle school	27%
65 or over	0%	High school	18%
		Undergraduate degree	9%
Tianyar Village, Bali	100%	Postgraduate degree	9%

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[3] We provide a glossary (Table 3) for multiple important key words used by participants (in Indonesian and Balinese) that have no direct translation to English.

Qualitative Analysis

Interviews were translated into English and then transcribed by ZB and LMP (authors fluent in both languages). This was done manually due to the lack of speech recognition software in Indonesian and Balinese. We then followed four stages: (1) coding, (2) assigning themes, (3) structuring and (4) comparing answers between interviews and focus groups.

Stage 1 followed the thematic coding analysis guidelines of Braun and Clarke (2006), which involved the generation of numerous category codes, without limiting the number of codes (Charmaz, 2006). For stage two, we listed key emerging ideas (McKinley & Ballinger, 2018; Saldaña, 2021) from words or phrases interviewees used frequently (Nyumba et al., 2018). Each interview question (Table 1) directly corresponded with one of the key emerging themes. Stage 3 involved identifying reoccurring themes with connecting and/or opposing views (Charmaz, 2006). Finally, in stage four we compared the responses of the individual participants with those of the focus groups.

Results and Discussion

Perceived Value of Coral Reefs

The community's perceptions of the value of coral reefs emerged as a key positive factor influencing EAs towards coral reef restoration and were divided between two main themes (1) development of marine ecotourism, and 2) increased fishing yield (Fig. 2). The interviewees described how Tianyar's coral reefs had earlier been exposed to coral mining (manual removal of patches of reef used a valuable construction material) that resulted in serious coral degradation. Since these harmful activities were stopped, an improvement of EAs in the village has led to the (reported) recovery of the marine environment:

> "Comparing the situation now to five years ago, we have observed a substantial improvement in coral health and overall cleanliness of the environment" (FG1).

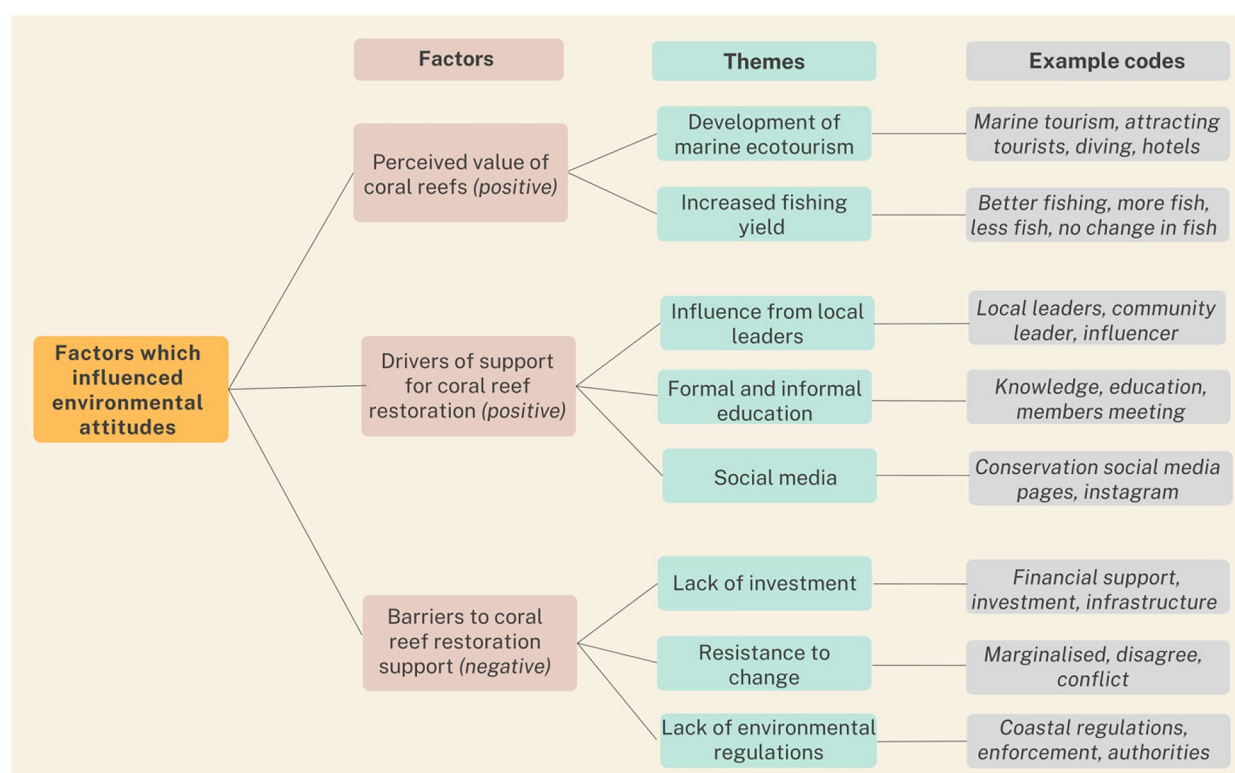Interviewees described the coral reef restoration work that has taken place:

Fig. 2 Connecting diagram highlighting the factors which were shown to influence the communities environmental attitudes towards coral reef restoration, as well as key themes and examples of their indicative codes

"Before the conservation programme started, there was only bare sand, but now after we have deployed around 8000 artificial reef structures, a large number of fish populations have come back again. The corals now grow by themselves, so natural recruitment is happening, without our intervention to transplant the corals" (I1).

Several participants commented that this work has had direct benefits on the marine environment and stated that after four to five years of restoration, the coral reef is now in good condition. Two main reasons emerged for community support of these restoration efforts: concern for the environment and perceived economic prospects associated with coral reefs, mostly ecotourism development (cf. Rizzi et al. (2020) who showed that perceived financial self-benefit is an important factor in driving PEBs). Generally, our participants indicated enthusiastic support for the development of marine ecotourism due to its potential to provide new, relatively well-paid jobs and improve livelihoods:

"Tianyar has high potential to be developed as a marine tourism destination, because we have very beautiful natural coral reefs and many variations of fish species" (I1).

"I am hoping to become a dive guide or instructor so that I can teach new guests to dive" (I5).

It has been widely acknowledged that eco-tourism developments can provide economic opportunities to areas with high unemployment (Garrod et al., 2003; Shani et al., 2012). Alongside generating socio-economic benefits, eco-tourism can also help to protect (and often actively restore) local environments (Mangubhai et al., 2020).

Our respondents indicated that the community's reef restoration efforts in Tianyar were largely driven by motivations to improve their livelihoods, for example: "the conservation programme has improved our incomes and quality of life, and that is one primary reason we choose to support it" (FG1). Berkes' (2010) study on a fisher community in Les Village, Bali, found that fishers chose to engage in their local coral restoration project because they felt they would benefit financially from doing so (notably through increasing their fishing yields). Additionally, our personal communication with the local community in Nusa Penida (Boakes, Hall, Ampou et al., 2022a) showed that coral restoration had led to the generation of tourism, which created new, higher-paid jobs for local people. These improvements in livelihoods generated local support to continue work to protect local coral reefs (cf. Romañach et al. (2018) regarding mangrove reforestation in India). Concerns were raised several times during our interviews that many people had joined restoration efforts purely for economic reasons, without a genuine desire to protect the environment. For example:

"I don't think the local people genuinely care or are aware about environmental protection. Even though they join conservation groups, I have observed that their actions are not representative of environmental awareness at all. For instance, they keep throwing away waste while they are sitting on the beach" (I1).

Stem et al. (2003) and Boakes, Hall, Ampou et al. (2022a) note that it can be problematic if support for marine restoration is driven purely by financial gain because it will consequently diminish should profits decrease.

One interviewee (I2) described the local community as "50% of people as fisher, 30% as farmer, 20% as trader," reflecting the continued centrality of fishing for the local community and their perceptions of the value of coral reefs. Research has shown that localised fisheries yield can increase as a result of artificial reefs (ARs) through increased production of commercial species (Ramos et al., 2019; Santos & Monteiro, 1997) as well as establishment MPAs as a result of the 'spill-over effect' (Di Lorenzo et al., 2020; Lenihan et al., 2021). Some interviewees discussed the benefits of the restoration work to fish populations:

"[because of the MPA and ARs] fish have come back to the area, particularly fish that are commonly consumed by local people, such as snapper fish. There are [now] so many of them and this is benefitting local fishers" (I1).

Despite this, most fishers did not report experiencing an increase in fishing yield, likely because the species they target are often caught far from the AR / MPA, and are not species generally found on the artificial reef. It is also important to note that 'no change' in fishing yield may be positive, as MPA establishment can sometimes lead to initial reductions in yield, especially if it prohibits fishing in a previously productive fishing area (Goñi et al., 2011).

Drivers of Support for Coral Reef Restoration

Drivers of support for coral reef restoration fell into three main themes (1) influence from local leaders,

2) formal and informal education, and 3) social media (Fig. 2). Bakari et al. (2017) showed that successful changes in EAs are often created by local leaders who influence attitudes among their constituents, a finding reflected in our interview data:

"[local leader name] has an important role in influencing local people too, for example through beach cleaning, or turtle hatchling protection" (I4).

"Local leaders encourage people that are throwing away litter on the beach to change their habits. The leaders can influence people's behaviours" (FG1).

Local leaders who have positive EAs and have influenced others within the community were described as having: "connected foreign volunteers and scientists with members of the fisher conservation group and the general community" (I1) (see also Schwartz, 1992, 2012; McLeod et al., 2009; Frey & Berkes, 2014; Trialfhianty, 2017).

Other reasons for local support of restoration efforts include the view that the sea is a source of food and livelihood:

"As indigenous people in Tianyar, the sea is important as a food source for us and for many of my family's livelihoods. This for us is an important reason to protect the marine environment" (I7).

Another respondent cited Hindu religious beliefs and traditional scriptures as a reason to support restoration efforts:

"In Sundari Bungkah Lontar [traditional scripture] it is mentioned that the function of the sea on earth is like vital arteries in our body. So if the sea is unhealthy it will make us unhealthy as well" (I2).

Our interviews also revealed limited environmental knowledge among community members. For example:

"Local people lack knowledge and understanding about the importance of conserving the environment" (I3) "Information about coral conservation and the environment has been spread traditionally through members meetings" (FG1),

which was described as "an ineffective way of communicating environmental issues and coral reef conservation" (FG2). Fishers have a relatively limited understanding of the ecological and socio-economic benefits of coral reef restoration since there is very limited formal education on environmental awareness in Bali and wider Indonesia (Parker & Prabawa-Sear, 2019). One respondent I1 discussed the link between high-level formal education and environmental care: "I think there is a link between the level of formal education and the level of environmental awareness. Those who have studied [at university] in cities have seen good waste management systems, with waste bins and plastic sorting points. When they come back to the village they won't throw away their waste anymore, but will find a bin instead" (1I) (see also Littledyke, 2008; Strieder Philippssen et al., 2017).

However, interviewees explained that informal teaching sessions with children in the village appear to be an effective method of environmental education:

"Before the educational programme [Yayasan Widya Sari] started, most young people had no idea about the marine life on their beach. They now know how beautiful their local marine life is because they have been able to go snorkelling with international volunteers and see it" (I5).

These sessions were provided mostly by international volunteers, many of whom visit specificially to teach students about the environment:. "The environmental activities were first initiated by international volunteers here and I believe they have played an important and positive role in changing local people's attitudes" (I5). Throughout our study we found local perceptions on the presence of foreigners were generally very positive (however, see also Cohen, 1982; Fabinyi, 2010; Boakes, Hall, Ampou et al., 2022a; among others).

The importance of informal education as a powerful tool for changing EAs has been widely noted (Parker & Prabawa-Sear, 2019; Steg & De Groot, 2018; Varela-Candamio et al., 2018). Our interviews indicated that the youngest generation in Tianyar are the most aware about the environment (see also Williams & Page, 2011). Based on the Environmental Citizenship Model (Hungerford & Volk, 1990), our study community in this case study can be described as at an earlier stage of educational involvement (basic sensitivity to and knowledge of the environments). The community's level of involvement environmental initiatives would largely depend upon their education and awareness of the environment. Further increasing environmental education within the village would encourage more of the community towards 'ownership' and 'empowerment' variables, which would further improve EAs, generate PEBs and lead to greater support for coral reef restoration.

Barriers to Coral Reef Restoration Support

Barriers to coral reef restoration support proved to be a key negative factor influencing EAs towards coral reef restoration and comprised three main themes: (1) lack of investment, 2) resistance to change, and 3) lack of environmental regulations (Fig. 2). Lack of investment was consistently cited as the main factor hindering the development of ecotourism, especially in terms of waste management[4]:

"…we want to improve our waste management, but we haven't received the financial support to do it" (I6). "There is still limited help from the government, and no trucks taking the plastic away" (I5). "…most waste gets thrown away or goes into holes that are dug into the ground, or is burnt" (I7).

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[4] The lack of waste management on the island, as highlighted by the interviews, caused Bali to declare a state of 'Garbage Emergency' in 2017 (Garcia et al., 2019).

Table 3 Glossary of key words used by participants within interviews

Key words	Meaning
Desa Adat	Customary village (semi-autonomous village governance system that is responsible for organising religious ceremonies and socio-cultural activities). Desa Adat has the authority to produce its own rules based on a members agreement
Desa Dinas	Administrative village (village governance system that is responsible for managing government-related administrative matters)
Banjar	A small unit of a community group that share responsibilities to perform religious ceremonies and socio-cultural activities. Desa Adat consists of several Banjars
Awig-awig	Laws produced by Desa Adat
Pecalang	Desa Adat security force
Yayasan	Non-profit foundation

Substantial financial investments are often needed to create long term changes to EAs (Lavelle et al., 2015).[5] Regions in north Bali receive relatively few tourists compared to mass tourism centres in the south and are consequently not a likely priority for investment (Kostić & Petrović, 2013; Khamdevi & Bott, 2018).

Resistance to change, the second barrier to reef restoration efforts, can be a contributing factor that predicts behavioural intention and thus behavioural outcomes (Nordfjærn et al., 2014). Some conflicts and issues related to ecotourism were reported by fishers:

"…there are some people who argue with us when no fishing zones are established. They insist that the sea belongs to everyone, and they can fish anywhere they want" (FG2).
"So far, we haven't experienced issues, but we hope we can still do our job as fishers [with the development of ecotourism]. If we are marginalised, I think we will fight. It is very important to make conservation, tourism, and fishing zones" (FG1).
"…. potential issues with stakeholders, for example "boat owners complaining about divers or snorkellers in the areas where they went to fish" (I4).

It appeared that this resistance to change was driven by concern for their livelihoods and culture, which they fear might impacted by the proposed development. Marine restoration and eco-tourism projects are far more likely to succeed when stakeholder opinions are listened to and their concerns addressed. In the case of development of eco-tourism in Tianyar, it is necessary to accommodate the concerns of stakeholders within planning processes (Pedju, 2018; Waayers et al., 2012). Responses showed that most resistance to change (especially in terms of waste management) came from the older generation. Intervention

strategies may improve EAs, including provision of education and consideration of stakeholder feedback,[6] as well as setting community goals with signed pledges (Steg & De Groot, 2018).

Participants generally agreed that local environmental regulations, as well as enforcement practices to support them, are insufficient and hindered positive changes to EAs:

"We need more rules from the local government for environmental protection" I4.

"… authorities need to be involved with strictly enforcing environmental regulations. Otherwise local people will not follow them" (I8).

This latter view is also reflected in the West Bali Marine Park MPA, where poorly enforced regulations led to user non-compliance (Doherty et al., 2013), suggesting that enforcement of regulations by authorities are necessary for success. Additionally, one informant noted that:

"There is a lack of communication of environmental rules and this needs to be made clearer. For example, sometimes fishers aren't certain if they're allowed to fish in an area or not - this is a common theme across Bali's marine protected areas" (I4).[7]

Some respondents commented that plans were being developed to create regulations:

"… we are planning to create village rules to protect the environment, particularly the marine environment. But it may take quite a long time to do this" (I2).

FG2 noted the importance of the Desa Adat and the Pecalang (Table 3):

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[5] In contrast, Terrier and Marfaing (2015) showed that although large environmental initiatives sometimes require substantial financing, other small behavioural changes (such as reducing single use plastics) are much less onerous.

[6] This is particularly relevant in terms of the community's lack of environmental knowledge and waste management problem. However, this is a particularly sensitive topic, and if someone's waste management practices are criticised: "… they will be offended, and this will trigger conflict between us. Local leaders need to approach them and talk to them personally" (FG2).

[7] See also Suparno et al. (2019).

"… the pecalang play an important role in Desa Adat law enforcement. These rules are often more effective than the government laws that are enforced by police because people are more fearful of Pecalang."

Recommendations

The following recommendations are based on the responses and opinions of interviewees.

Continuing Community Environmental Education

There should be continued support for the work of the 'Yayasan Widya Sari' (the local learning centre) and similar initiatives to raise young people's awareness about environmental issues and marine restoration (Blythe et al., 2021; Varela-Candamio et al., 2018). Engaging with 'The Environmental Citizenship model' (Hungerford & Volk, 1990) would further increase environmental education within the village encouraging more community identification with 'ownership' and 'empowerment' that would lead to greater support for coral reef restoration. As our results indicate that Tianyar fishers have a relatively limited understanding of the economic benefits of coral reef restoration, specifically with regards to increased fishing yield, we recommend further resources be allocated to increase their awareness of these benefits, which would likely generate more support for the restoration programme (Leisher et al., 2012).

Strengthening Regulations and Improving Enforcement

In consultation with stakeholders the local government should strengthen environmental regulations in the village, specifically with regards to waste management, including imposition of fines for disposing of waste on the beach and other public areas, as well as creating clear zones for marine users. These regulations need to be strictly enforced by the relevant authorities to ensure compliance. We also recommend that alongside the establishment of official government regulations, the Desa Adat (and their associated Pecalang security force) establish and enforce locally specific laws to protect the environment.

Increasing Support for Eco-Tourism

Village leaders' ability to approach local government and access various state-owned enterprises and social responsibility government grants is crucial to develop ecotourism within the village (Bhuiyan et al., 2011). However local universities may also assist village leaders in creating ecotourism initiatives, as well as expand potential sources of grants. As with all our recommendations, we emphasize the crucial importance of engaging local stakeholders in the development of ecotourism initiatives.

Continue Constructing Artificial Reefs

ARs have been used across Bali as a habitat enhancement tool to successfully restore marine biodiversity and abundance (Puspasari et al., 2020; Syam et al., 2017) while at the same time enhancing positive local attitudes towards their environment. In terms of achieving restoration objectives, it is important that programmes follow guidelines of 'best practice' (Boakes, Hall, Jones et al., 2022b).

Utilising the Influence of Local Leaders

The influence of local leaders in shaping EAs within the local community is widely recognised (McLeod & Palmer, 2015; Steg & De Groot, 2018; Trialfhianty, 2017), including the use of intervention strategies to increase pro-environmental behaviours through the widespread provision education and feedback, as well as setting community goals with signed pledges. This is particularly relevant in terms of Tianyar's communities lack environmental knowledge and waste management problem.

Many of our recommendations for our study in one village in Bali are also relevant for marine and terrestrial restoration in the global north. Embedding the generation of positive EAs within the wider community, based on clear personal gains, social norms and overcoming barrier to change is very different to many initiatives used in global north countries, where the overwhelming response to plastic pollution has been based on an approach encouraging use of reusable products, such as water bottles or coffee cups (Stafford & Jones, 2019a). However, the hope that undertaking one PEB will lead to 'spill-over' into more beneficial behaviours is disputed by current evidence (Maki et al., 2019; Stafford & Jones, 2019b). A holistic, community-based approach such as we recommend here or as adopted by the Coast4C projects in the Philippines (Blanco, 2021), may provide the necessary conditions to facilitate positive EAs in coastal communities, but such approaches may require development, or redevelopment, of closer knit communities than currently exist in many countries (e.g., Monbiot, 2017).

Conclusion

Our results highlight several factors that influence local attitudes towards the restoration of coral reefs, including perceived value of coral reefs (such as perceived changes in fishing yield), drivers of support for coral reef restoration (such as influence from local leaders), and barriers to support for coral reef restoration (such as lack of investment), and suggest that the restoration programme had influenced EAs within the community, which potentially have led to an increase in PEBs (notably, increased support for the coral reef restoration programme and its objectives). These behavioural changes are mostly driven by the perceived economic prospects that the community associate with restoration programme. This qualitative research adds new knowledge to the existing scientific literature on the topic of EAs and coral reef restoration programmes, however this case study is limited to one fishing village in north Bali. It is recommended that qualitative research continues to be conducted in Indonesia (and other low-middle income nations) to further investigate the link between ecological restoration and EAs.

Declarations

Permits A research permit was obtained from Indonesia's Ministry of Research (BRIN). Research permit number: 15/SIP.EXT/IV/FR/5/2023.

Research Ethic We further confirm that any aspect of the work covered has involved human participants was approved by the Bournemouth University Ethics Committee (reference number: 37431). Written consent to publish potentially identifying information, such as details or the case and photographs, was obtained from the patient(s) or their legal guardian(s).

Conflict of Interest Author (ZAB) was involved with the initial start-up and management of NGO. He personally knew some of the participants, which may be considered as potential competing interests. Participants responses were anonymised throughout. After fieldwork finished, research results were presented to local stakeholders to maintain objectivity. ZAB declares no financial conflicts of interest. All other researchers had connections with the NGO and declare no other conflicts of interest.

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