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Executive Summary

Proyecto Corales is a volunteer committee in the Bay of Samara that seeks to restore the coral reef in the area. With support from the Instituto Nacional de Aprendizaje (INA), the group is the first community driven coral gardening project. In addition to performing coral gardening for the rehabilitation of the reef, the group seeks to educate the local community and society at large and to perform activities that will mitigate the decline of the reef. While many of the activities are planned, their full implementation has not been carried out. Because of this the analysis attempts to capture present and future impacts.

The analysis presented here was carried out adapting the SLCA methodology recommended by the UN and SETAC to the local realities. Primary data gathering was done through focus groups with different stakeholders and this was complemented with desktop research.

The analysis finds that Proyecto Corales provides significant beneficial social impacts. Successful restoration can add up to \$350,000 per ha per year in economic benefits, while the group is increasing the protection of cultural assets, providing increases in skills and training, and generating access to local natural resources. However, the group needs to focus on its engagement with local community to increase awareness and transparency. This will not only increase their beneficial social impacts but increase their chances for success for other planned activities.

Introduction

This report provides a Social Life Cycle Assessment (SLCA) of the service provided by the Comite de Corales in Sámara, Costa Rica. Their mission is to restore the coral reef in the Samara bay through coral gardening and engagement activities. An analysis of the social impacts of their activities is given following the SLCA guidelines provided by the UN Environmental Programme (UNEP) and SETAC (2009). These impact analyses are grouped by the stakeholder category most likely to be affected by the impacts. This report analyzes potential impacts in the UNEP/SETAC (2009) identified SLCA stakeholder categories - specifically workers, local communities, society, consumers, and value chain actors. Finally, this report offers recommendations, based mainly on feedback from semi-structured stakeholder

interviews, for Proyecto Corales which could increase effectiveness and engagement with stakeholder groups.

Background

Coral and Coral Decline

Coral reefs support one of the greatest sources of biodiversity on the planet. They have a direct and substantial impact on the food security, economic security, cultural heritage, and recreational value experienced by coastal communities (WWF n.d.). Coral reefs also provide a number of critical ecosystem services: regulating climate, cycling nutrients, promoting genetic diversity, preventing erosion, fixing nitrogen, maintaining the global calcium balance, and sequestering carbon dioxide (Putnam et al. 2017; de Groot et al. 2012; Kuhlmann 1988; Hallock 1997). Yet this invaluable natural resource is experiencing a state of rapid decline worldwide.

Globally, roughly one quarter of coral reefs have died or suffered severe damage, and two thirds of these reefs are considered threatened (WWF n.d.). The majority of coral decline can be traced to anthropogenic causes, both direct and indirect. Major factors associated with decline include rising water temperatures and ocean acidification due to climate change, sedimentation, pollution from terrestrial water runoff, destructive fishing practices, coastal developments, coral mining, and damage due to tourism (WWF n.d.; Putnam et al. 2017; De'ath et al. 2012). The threats to coral are numerous, and all threats place a tremendous burden on coastal communities whose livelihoods rely in some part on the survival of the coral (Ahmed et al. 2004).

According to informal interviews with community members and the Instituto Nacional de Aprendizaje (INA), over the past two decades, ecosystem damage in the South Pacific region of Costa Rica specifically has led to a 30 percent loss in coral coverage. Following global trends, reef decline is mainly attributed to anthropogenic causes. This decline coincided with overfishing, including destructive bottom-trawling and blast fishing practices. Now, increasing coastal development, substantial waste water contamination, and sediment laden runoff from teak plantations continue to threaten what is left of the native reef. Natural phenomena including hurricanes, cyclones, and tsunamis have also negatively impact reefs in the area (Wilkinson et al. 2008).

This SLCA analysis focused on a reef off of the coast of Sámara, Costa Rica, a community in the Guanacaste Province. In 2013 University of Costa Rica biologists conducted an evaluation of the state of the reefs of Sámara and neighboring community Carrillo. The reefs were described to be in poor condition, with prominent species of coral considered to be “mostly dead.” The team attributed the poor conditions to a decline in fish populations; a result of tourism and fishing (Evans, 2013).

Proyecto Corales

In June 2017 the Ministry of Environment and Energy (Ministerio de Ambiente y Energía, MINAE) contacted members of the community of Sámara, Guanacaste and requested they work with INA to develop the region's first community organized coral gardening program--an initiative focused on improving the condition of the marine ecosystem. The INA team included Marine biologist Carlos Pérez and Dive Master Instructors Christian Gomez and Rodolfo Vargas who would train the community members and advise them on the project. Proyecto Corales began shortly thereafter with fifteen local Sámaraman citizens--including tour operators, civil society leaders, and educators--since trained in coral gardening techniques. The group regularly visits and tends to an aquatic coral nursery in Playa Sámara. Since the project began Proyecto Corales has gathered valuable information related to coral polyp and reef growth and collected best practices for the project's long-term success.

Coral Gardening

Proyecto Corales follows established coral gardening protocols (Rinkevich 2006; Edwards & Gomez 2007). Coral gardening generally begins with identifying an optimal location: an area where the flow of water will naturally help remove mucus and provide oxygen, where movement of the nursery will eliminate organic material and sedimentation from the built structure, where light is readily available for photosynthesis, and where the coral will be inaccessible to coral-eating fish and invertebrates (Rinkevich and Shafir n.d.). Live coral fragments are then transplanted to the selected locations in the hope that offering the best possible conditions improves their rate of growth and survival. Other gardening projects in the south of Costa Rica have worked with *Pocillopora damicornis*, *Porites lobata*, and *Pavona florida* species of coral (Pérez 2018). In Samara, the project is growing *Porites lobata*, *Psammodora stellata*, *Pocillopora damicornis* and *Pavona gigantea*.

The technical process involves constructing a growing apparatus (a "staghorn" or "tree"), developing concrete substrates ("cookies") for the coral fragments, collecting and anchoring the coral fragments to the cookies, and finally installing the entire apparatus in-situ. The sites are routinely visited to clean the structures and monitor coral growth. Because corals require sunlight to survive, one of the group's most important responsibilities is to clean the nursery structure and concrete supports.

Coral gardening practices offer significant potential for reef restoration. A recent study (Schopmeyer et al. 2017) on the restoration of *Acropora cervicornis* ("Staghorn corals") in the Caribbean demonstrates the viability of coral gardening practices; analyzing early growth among several restoration sites in Florida and Puerto Rico. Replanted Staghorn corals had productivity and survival rates comparable to those of wild corals in the area. Similarly, work done in the Seychelles (Montoya-Maya 2016) found a reported "three-fold increase in fish density, and a two-fold increase in coral settlement and recruitment" at degraded reef sites where nursery grown corals were transplanted. Past success with coral gardening suggest that Proyecto Corales' efforts could bring significant improvements to the reef at Playa Sámara.

Community Background in Sámara

Coastal tourism represents a dominant proportion of general global tourism (UN First World Ocean Assessment, 2016) and coral viewing specifically, motivates a large component of the coastal tourism sector. People are willing to travel far and expend significant amounts to view native coral reefs (UN First World Ocean Assessment, 2016). Tourism is central to Costa Rica's nationwide economy and Costa Rica has garnered the reputation as a hub for ecotourism.

The small beach community in Sámara, approximated at 3500 people in the most recent 2011 census, is now a destination for many foreign tourists (CREST, 2014). This marks a shift over the past several decades from a primarily agriculture-based economy (CREST, 2014). In Sámara, the reef holds particular significance to the community given its socio-economic impacts related to tourism-based employment, commercial fish catch, and food availability.

Use of SLCA Methodology

The relevance of the reef to community well-being requires a comprehensive assessment of the potential or real socio-economic costs and benefits of Proyecto Corales' efforts; the S-LCA methodology is thus applied to evaluate the overall life cycle impacts of the organization's coral regrowing service. The methodology revolves around identifying the main stakeholder groups involved in the service and the impact subcategories associated with each stakeholder group. Table 1 below shows the identified stakeholder groups and Table 2 shows the sub-categories considered and their impacts.

To gather the appropriate data for analysis of the impacts desktop research on similar projects was conducted and more importantly semi-structured focus groups were conducted with stakeholders. The focus groups gathered stakeholders according to their categories. Four focus groups were conducted with the following groups: Proyecto Corales Volunteers, Local Fishermen Association, Development Committee (Asociacion de Desarrollo Integral ADI) of Samara, and ADI of Carrillo. Samara and Carrillo are the two communities that enclose the bay of Samara. It is important to note that the Proyecto Corales group has representatives from local communities, national local commerce and tourism, local Watershed committee, local fishermen, and local community leadership. This diversity forms one of the strengths of the group and provided a more detailed understanding of the project.

Table 1: Stakeholder Categories Considered in the SLCA and their definitions

Stakeholder Categories	Stakeholder Definition
Workers	This category includes the members of the <i>Proyecto Corales</i> Committee (15 members). All committee members are ‘employed’ by Proyecto Corales on a voluntary (unpaid) basis. The same team of individuals is engaged across the entire lifecycle.
Local Community	This category includes the people who reside permanently in Sámara.
Consumers	This category includes the people, both Costa Rican citizens and foreigners, who do not reside in Sámara and visit for purposes related to tourism.
Society	This category refers to Costa Rican society

Results

In this section we provide an overview of the findings. Table 2 below provides a summary of the results from each impact sub-category.

Table 2: Impact Subcategories, Types of Impacts, and Recommendation for Improvements According to Stakeholder Interviews

The scope of this study focuses on the status of Proyecto Corales as an organization at present; however, the SLCA impacts related to coral reefs, assume success of coral regrowth as indicated to date by biological surveying.

Local Community		Consumer	
Indicator	Impact	Indicator	Impact
Community engagement	Needs Improvement/Careful planning	Health and safety	Positive Impacts
Cultural heritage	Positive Impacts	Feedback mechanism	Positive Impacts
Local employment	Needs Improvement/Careful planning	Transparency	Positive Impacts
Access to immaterial resources	Positive Impacts	Consumer commitment to sustainability issues	?
Access to material resources	Positive Impacts	Worker	
Safe and healthy living conditions	Positive Impacts	Indicator	Impact
Secure living conditions	Needs Improvement/Careful planning	Professional growth	Positive Impacts
		Equal opportunities/discrimination	Needs Improvement/Careful planning
		Society	
		Indicator	Impact
		Public commitment to sustainability issues	Positive Impacts
		Contribution to economic development	Positive Impacts
		Technology development	Positive Impacts
		Legend	Positive Impacts
			Needs Improvement/Careful planning
			Negative Impacts

Workers

Impact subcategories considered to be relevant for Workers include *Equal Opportunities* and *Professional Growth*.¹ Male-female employment inequality is highly relevant in Costa Rica. On a national level, labor force participation rates (expressed as a % of the population over the age of 15) for males is 74% compared to females at 46% (World Bank, 2018). The *Equal Opportunities* subcategory was applied to assess the level of inclusion of females in *Proyecto Corales*' efforts. The group is currently male-dominated and therefore should consider strategies moving forward that will support the inclusion of more female volunteers.

Professional Growth is evident in the beginning stages of Proyecto Corales: members were specially trained to participate in coral gardening, thus acquiring a new set of skills. Interviews showed a sense of enthusiasm amongst those involved in Proyecto Corales, a desire to continue working on the initiative, and an interest in further education and training. Proyecto Corales volunteers appear to benefit from an uplifting and rewarding workplace. The initiative should promote continued opportunities for personal and professional development, especially

¹ The traditional UNEP impact subcategories have been expanded to include "Professional Growth" following the work of Revéret et al. (2015) and Arcese et al. (2017).

as research surrounding coral reefs evolves. Personal and professional development to date has focused on biological/ecological components of *Proyecto Corales*' work; to enhance the organization's impact opportunities for further growth should be expanded to areas including outreach, education, community engagement, and communication.

Local Community

All life cycle steps in coral regeneration involve the Local Community; subcategories considered for social impacts at various stages include *Community Engagement*, *Cultural Heritage*, *Local Employment*, *Access to Immaterial Resources*, *Access to Material Resources*, and *Safe and Healthy Living Conditions*, *Secure Living Conditions*. To begin with *Community Engagement*: *Proyecto Corales* regularly engages with elementary schools in the local community to provide education outreach on the ecological importance of coral reefs. The organization is looking to expand its outreach efforts, both in the strength of the content of information provided and in the breadth of the audience it reaches.

Although *Proyecto Corales* is not yet regularly engaging with older audiences in the local community, it has plans to do so in the future by partnering with influential organizations like community development groups (ADIs). Stakeholder interviews, however, stressed the need for increased engagement with the community. Interviews with community fishermen and community leaders demonstrated community knowledge of *Proyecto Corales* was minimal. Many stakeholders felt as though the problem was a "lack of information". Others wished the coral committee would do more outreach to increase trust. Therefore, while efforts and planned outreach by *Proyecto Corales* does aid community engagement, this is an area that requires further attention.

In evaluating *Cultural Heritage*, the central mission of *Proyecto Corales*, to restore the coral reef in Sámara, was heavily factored. In stakeholder interviews, many locals reminisced about the past state of the reef and the inherent value its existence brought to the area. The reef was once a source of pride for the area and its regeneration would renew such sentiments. Numerous stakeholders, however, expressed pain in interviews that their children and future children would not be able to see the reef as it once was. They regarded the reef as a sort of cultural offering, and therefore the attempt by *Proyecto Corales* to restore the reef is an attempt to return this cultural element back to Sámara.

In evaluating the *Local Employment* indicator, the economic characteristics of Sámara were taken into consideration. It is difficult to attribute the decline of the reef to the low levels of employment and the shifting economic focus over the past twenty years. The shift from an agriculture to a tourism based economy has had varying impacts on Sámara. While the Guanacaste Province receives one of the largest distributions of tourists in Costa Rica (in 2012, 42.5 percent of Costa Rica's international visitors visited the Guanacaste region at least once during their travels), it also holds the highest unemployment levels of any province within the country (CREST, 2014). The seasonality of tourism in Costa Rica leaves many employees with limited economic opportunities in the low season and thus introduces a volatility to employment in Sámara (CREST, 2014). In interviews, many stakeholders brought up the potential for more jobs in the low season if the coral was back; others felt there would be increased jobs due to

increased tourism from the reef. Conversely some expressed concern that their jobs security is threatened by tourism and that the inherent seasonality of tourism creates a vicious cycle.

The World Wildlife Foundation estimates that coral reefs, if managed well, can provide up to 15 tons of fish/seafood per square kilometer each year (WWF n.d.). A more comprehensive report by De. Groot et al., provides 2007 estimates of the international dollar value of coral reefs per hectare per year. Table 3, provides the estimates generated by De. Groot et al.

Table 3: Estimated economic benefits of healthy coral (de Groot et al., 2012)

Coral Reef Values (values in Int.\$/ha/year, 2007 price levels)	
Provisioning services	55,724
1 Food	677
2 Water	--
3 Raw materials	21,528
4 Genetic resources	33,048
5 Medicinal resources	--
6 Ornamental resources	472
Regulating services	171,478
7 Air quality regulation	--
8 Climate regulation	1188
9 Disturbance moderation	16,991
10 Regulation of water flows	--
11 Waste treatment	85
12 Erosion prevention	153,214
13 Nutrient cycling	--
14 Pollination	--
15 Biological control	--
Habitat services	16,210
16 Nursery service	0
17 Genetic diversity	16,210
Cultural services	108,837
18 Esthetic information	11,390
19 Recreation	96,302
20 Inspiration	0
21 Spiritual experience	--
22 Cognitive development	1145
Total economic value	352,249

The potential for a regenerated reef to aid in economic activity is clear. However, due to the variability of tourism and the mixed sentiments regarding in Sámara, local employment will depend on the levels of reef regeneration, seasonal economic stability in Sámara, and the attraction of tourists to the reef.

Access to Immaterial Resources was evaluated in terms of knowledge: specifically the education efforts planned by Proyecto Corales in regards to the reef and its ecological importance. The education deficit in Sámara is likely a significant impediment to economic progress. Given that coastal communities like Sámara have shifted towards the tourism industry, the industry would likely benefit from target education with a strong emphasis on cultural and environmental preservation. Proyecto Corales's mission, though on a small scale, is an attempt to increase community knowledge of the coral benefits and provide opportunities related to reef conservation.

The analysis done by De. Groot et al. can also be applied to the last three indicator categories: *Access to Material Resources*, *Safe and Healthy Living Conditions*, and *Secure Living Conditions*. In *Access to Material Resources*, improved ecosystem services are likely to impact community access. The regulating and habitat service benefits outlined by De.Groot et al. showcase specific ecosystem benefits likely to be incurred with a regenerated reef. Stakeholder interviews also voiced recognition of the general associations between resources available for communities and conservation. In evaluating *Safe and Healthy Living Conditions* the analysis by De. Groot et al. shows benefits in provisioning services which hold value to community health. In interviews stakeholders mentioned that healthy coral would bring more fish and that, for families who rely on activities like spearfishing, a health reef would mean healthy living. In evaluating *Secure Living Conditions*, however, stakeholders expressed benefits of potential increased income stability due to reef generation but warned of the negative impacts of increased tourism due to the reef. While the reef may hold significant economic value, *Secure Living Conditions* brought up concerns similar to the *Local Employment* indicator concerns.

Consumers

Impact subcategories considered to be relevant for Consumers included *Health and Safety*, *Feedback mechanism*, and *Transparency*. Currently, with limited information regarding those who visit Sámara for reasons related to tourism, there are no reasons to project any negative impacts regarding their health and safety, the feedback mechanisms set in place by Proyecto Corales, nor overall transparency.

Society

Impact subcategories considered to be relevant for Society include a *Public Commitment to Sustainability Issues*, and *Contribution to Economic Development*. Following precedent set by Martínez-Blanco et al. (2014), the level of *Public Commitment to Sustainability Issues* is assessed on the existence of educational campaigns targeting citizen engagement. Proyecto Corales demonstrates a public commitment to sustainability through its current sub-project aimed at creating an educational curriculum “to engage local citizens, and educate the future

generations of [the] town on the marine-coastal environment” (Proyecto Corales). Finalization of this initiative will provide concrete evidence of the organization’s public commitment to sustainability.

A healthy coral reef bolsters the local economy--provides a positive *Contribution to Economic Development*--with a variety of (ecosystem) goods and services from climate regulation to recreation (see Table 4).

Table 4: Goods and Services provided by Healthy Corals in the Coastal Zone based on Wilson et al. (2005).

<ul style="list-style-type: none"> ▷ Gas regulation ▷ Climate regulation ▷ Disturbance prevention ▷ Water regulation ▷ Water supply ▷ Soil retention ▷ Soil formation ▷ Nutrient regulation ▷ Waste treatment 	<ul style="list-style-type: none"> ▷ Pollination ▷ Biological control ▷ Habitat functions ▷ Refugium function ▷ Nursery function ▷ Aesthetic information ▷ Recreation ▷ Cultural and artistic information 	<ul style="list-style-type: none"> ▷ Spiritual and historic information ▷ Science and education ▷ Food ▷ Raw materials ▷ Genetic resources ▷ Medical resources ▷ Ornamental resources
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Costanza et al. (2014) estimate the value of a healthy, productive coral reef at \$352,000/ha/yr. Project efforts have the *potential* to significantly enhance economic development in the area. The degree of success Proyecto Corales has with regeneration of the reef holds potential to determine the degree of economic development realized in Sámara. Furthermore, successful regeneration of the reef in Sámara holds implications Costa Rican society as a whole.

Conclusions and Limitations

Analysis is largely based on planned activities, not activities that have been realized to date. The degree to which the positive social impacts are realized depends on the delivery of the service. Due to the subjective nature of this analysis, it serves only to inform Proyecto Corales and interested parties of the potential impacts of reef regeneration in Sámara. That being said, there are numerous potential positive impacts of the reef regeneration, depending on the success of Proyecto Corales. Further, it is necessary to tie the SLCA prepared here with other available resources, such as social hotspot database, and to complement it with an environmental life-cycle assessment.

Recommendations

Perhaps the most important recommendation for Proyecto Corales regards transparency and community engagement. Proyecto Corales should solidify avenues for engagement within

Sámara and communicate potential health and safety impacts of their operations to surrounding communities. Overall, their initiatives should promote continued opportunities for personal and professional development, especially as research surrounding coral reefs evolves. Personal and professional development to date has focused on biological/ecological components of Proyecto Corales' work; the organization's impact opportunities for further growth should be expanded to areas including outreach, education, community engagement, and communication. To expand project impact Proyecto Corales should consider investing resources in the development of new tools and improvement of relevant processes/tasks. The (re)establishment of a partnership with the University of Costa Rica could be beneficial for promoting research and development in coral gardening techniques.

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