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BENEFITS OF MARINE CONSERVATION PROGRAM: AN IMPACT EVALUATION APPROACH

Sopian HIDAYAT[1,*], Umi MUAWANAH[2], Isabelita M. PABUAYON[3], Muhammad RIDWANSYAH[4]

[1] Conservation Strategy Fund (CSF) Indonesia, Graha Simatupang, Tower 2, Unit C, Jl. TB. Simatupang, Kav. 38, Jakarta, 12540, Indonesia
[2] The Research Center of Socio Economics of Marine Affairs and Fisheries, BRSDMKP Building I, Jl. Pasir Putih I, Jakarta, 14430, Indonesia
[3] University of the Philippines Los Banos, Pedro R. Sandoval Ave, Los Baños, Laguna, 4031, Philippines
[4] University of Jambi, Jl. Raya Jambi - Muara Bulian KM.15, Ma. Jambi, Jambi, 36361, Indonesia

Abstract

The Coral Reef Rehabilitation and Management Program (COREMAP) is a marine conservation program providing capacity building for fishers and villagers, including training in business management, creating alternative livelihoods, and programs in marine resource management. This study evaluates the impact of the program by applying a quasi-experimental design using propensity score matching (PSM). The program outcomes are compared between people in COREMAP areas with control areas and COREMAP beneficiaries with non-beneficiaries. A survey of 684 households was conducted across the six districts in Eastern Indonesia. The results show positive livelihood impacts of COREMAP on coastal communities. In particular, beneficiaries are better off than non-beneficiaries concerning income from alternative livelihood sources and overall household income. The focus of livelihood support in reducing pressure on coastal resources appears to be an effective strategy. The management community unit plays a vital role in conserving coastal and marine resources within the project sites. Hence, there is much incentive for continuing such COREMAP's initiatives.

Keywords*: Marine conservation; COREMAP; Propensity score matching; Livelihood impact; Indonesia***.**

Introduction

Studies show marine protected areas (MPAs) positively influences community livelihood [1-3]. For instance, MPAs can contribute to poverty reduction through improved fish catches, job creation in tourism areas, better local governance, health improvement, and more women empowerment due to better income generated [1]. Besides, MPAs also improves social indicators such as welfare, food security, resource right, employment, community organization, and income [2]. Furthermore, an increased resource right was positively correlated with MPAs zoning and compliance with MPAs regulations. The study of Cohen *et al.* [3] on the MPAs in the Pacific islands concluded that by establishing MPAs, there is an improvement in fishery landing, best local governance, community organization, resilience and adaptation, health or security of marine protein supply, integrated resource management, cultural survival, and security of tenure. However, the MPA was also negatively affecting a minority of fishers due to

* Corresponding author: sopianhidayat99@yahoo.co.id

closing some of their fishing grounds. This group will be more prone to breaking the MPA rules.

Mizrahi *et al* [4] and Ahmadia *et al* [5] highlight that many studies on MPAs have less consideration on neither socioeconomic perspectives nor robust methods in evaluating the impact of MPAs. Baylis *et al* [6] suggested that the future nature conservation should mainstream the impact evaluation into their program. These studies suggest that socioeconomic factors are critical to the MPA planning process and need to undertake further research. Ahmadia *et al* [5] emphasized that rigorous impact evaluation is useful to highlight the challenges of MPA implementation and figure out the alteration of the ongoing monitoring program for the future appropriate program. Bowler *et al* [7] and Craigie *et al* [8] confirmed that rigorous impact evaluation by adopting robust evaluation principles is necessary to fill significant knowledge gaps on issues of protected areas. The impact evaluation study allows us to learn about the successes and failures implementing policy and ensuring further potential approaches have benefits to the environment and society. The study is also useful to inform the global conservation circle to reduce the repetition of unsuccessful projects.

Craigie *et al* [8] reveal that the low utilization of impact evaluation for conservation activities are due to fear of exposing failures, high cost, lack of technical capacity, misaligned incentives, perceptions that existing knowledge of how the program work is sufficient and complex in institutional arrangements. Conversely, there are several advantages of doing the impact evaluation study as noticed by Bonan *et al* [9]. There are easily understood by policy makers on what program works and does not work, providing clear efficiency and cost-effectiveness solutions, well-defined measures of a program's success, and increasing the knowledge of development processes. Moreover, the impact evaluation study is also useful to assess the pilot project before promoting to expand into the wider level. Therefore, Ahmadia *et al* [5] recommended that understanding the impact of program intervention is key for both science and management.

Measuring the impact requires to construct a counterfactual group as comparison of a treatment group. This uses to device other changes that may happen during the time that were unrelated to the intervention program as many factors affect the outcome as argued by Bowler *et al* [7]. The study concluded that it is impossible to quantify the effectiveness of program intervention without presenting a suitable comparator or counterfactual group. Huang *et al* [10] and Ahmadia *et al* [5] in their study set up a counterfactual group to evaluate the impact of an intervention program. Huang et al. study measured the impact of collective rights-based fishery management, while Ahmadia et al. assessed the Marine Protected Areas (MPAs) in the Bird's Head Seascape (BHS) in Indonesia. Both studies use counterfactual group rather than comparing before vs after which is potentially misleading because unable to control other changes. Without providing the counterfactual group in measuring the impact of the intervention, seeing the incremental value in outcomes before and after may lead to an incorrect decision about the effectiveness of management. Some studies [3, 5, 10] were mainstreaming the impact evaluation for MPAs but few of them focus on the socio-economic perspectives with the involvement of the counterfactual group. This paper attempts to study the impact of MPAs within the COREMAP areas in Indonesia.

COREMAP in Indonesia

One of the national programs in Indonesia along this line is the Coral Reef Rehabilitation and Management Program (COREMAP). The COREMAP program covered selected ecological hot spots within the declared MPAs, the covered area estimated at 336,651ha of coral reef, 7,383ha of seagrass and 9,493ha of mangroves. Coral reef ecosystems support livelihoods, particularly of small-scale fishers, in the Indonesian coastal and marine sector. Coral reefs are a significant productive asset for Indonesia and about eight million of small fishers are directly dependent on coastal and marine resources [11]. Through collaborative management partnerships, the project aimed to rejuvenate coral reef fisheries and diversify the livelihood

opportunities of participating fishing communities. It was assumed that a healthy reef ecosystem would have a significant impact on the economic performance of the coastal communities. First Phase was implemented from 1998 to 2004, which focused on the initiation phase to develop a basic framework for coral reef management in priority sites. Phase II (later will be referred as COREMAP II) was started in 2006 and completed in 2012, which aimed to (i) sustain the utilization of the coastal ecosystem, (ii) decentralize natural resource management, and (iii) raise income levels and improve living standards in the coastal zone and on small islands [12]. Phase III, focused on the institutional phase, it was supposed to start in 2015, but since the Marine Affairs and Fisheries Ministry released a new policy, this program was temporary discontinue.

The COREMAP II has invested in three main components, specifically, 1) institutional strengthening with the fund support of USD 16.6 million; 2) community-based and collaborative management (USD 41.6 million); and 3) public awareness, education and sea partnership (USD 11.7 million). All these components are expected to enhance people's welfare and improve the state of coastal and marine resources. COREMAP II provided about USD 1,120 (IDR 10 million) per year or USD 5,500 for five years as seed fund for each village to start the coastal resource management group. The seed fund was given to support alternative income generation for community improvement with the target, among others, to replace illegal and destructive fishing practices among fishers. Among the proposed alternative income activities are seaweed and fish cage culture, bakeries, and other small business operations [12].

Villages received social infrastructure fund amounting USD 1,100 to support the installation of public toilets, freshwater wells, village gates, small surveillance boats and boundary markers [12]. The project also embarked on two pilot activities involving management and certification of aquarium fish in two districts in the COREMAP II areas. Unfortunately, the World Bank [12] considered these two projects relatively unsuccessful due to lack of buyer support. Thus, there was insufficient evidence to prove that COREMAP had adequately improved the communities' welfare [12, 13]. Despite these shortcomings, the COREMAP project is considered a success in developing strong community awareness, commitment to sustainable fishing, and protection of the coastal resources around the area.

Earlier studies had evaluated the impact of COREMAP on the income of coastal communities. The IUCN [13] and World Bank [12] reports showed the positive impact of COREMAP on income and behavior of communities toward natural resources. The IUCN [13] found a positive link of COREMAP I program on awareness, commitment to sustainable fishing, and the protection of the living resource among local communities compared to before. World Bank [12] revealed that the income of beneficiaries for COREMAP II project increased by 10 percent as compared to their income in 2004 [12]. However, since there was no study on the counterfactual group for comparison with the beneficiary's group, such result being attributable to the COREMAP program may be inconclusive. This study addresses this limitation by evaluating the impact of COREMAP II on people's livelihood by comparing beneficiaries with non-beneficiaries (counterfactual group) and comparing COREMAP II areas with non-COREMAP II areas (counterfactual group).

Data and method

Data collection

Primary data were collected through household surveys in the COREMAP and non-COREMAP villages for three months within the first quarter of 2016. The data included demographic and socio-economic information on the fishers in both areas such as age, education, number of household members, income from non-fishing sources, fishing effort, fish catch, price of fishery products, production cost, and other relevant data.

To complement the surveys, Focus Group Discussion (FGD) was conducted in COREMAP II villages. This involved participants from COREMAP officers at the village level, fishers' community, and market actors. This was done to explore and obtain in-depth information about the range of opinions, perceptions, and ideas among different parties involved in the COREMAP II program.

Sampling sites

The COREMAP project in Indonesia is divided into two areas, the Western part of Indonesia, funded by the Asian Development Bank (ADB), and the Eastern part of Indonesia funded by the World Bank (WB). This study focused on the Eastern part of Indonesia due to high dependency on fishing activities and various issues on the degradation of marine resources. The COREMAP area consists of four provinces and seven districts, namely, 1) West Papua—Raja Ampat and Biak, 2) Southeast Sulawesi—Wakatobi and Buton, 3) South Sulawesi—Pangkep and Selayar and, 4) East Nusa Tenggara—Sikka. This study selected three COREMAP districts representing three provinces. The treatment districts are Wakatobi, Raja Ampat, and Pangkajene Kepulauan (Pangkep).

Table 1. Study sites of Treatment and Control in East Indonesia, 2016

Province	Treatment	Control
West Papua	Raja Ampat	Kaimana
Southeast Sulawesi	Wakatobi	Muna
South Sulawesi	Pangkajene Kepulauan	Makassar

Control sites are located in other districts but within the same province as the treatment group. The control districts differ from treatment group because they do not belong to the COREMAP II program areas and do not receive any program assistance. This study selected one district from each province that is neither very far nor too adjacent to the control group. Table 1 and Figure 1 show the COREMAP (treatment group) and non-COREMAP districts (control group) that were selected from the provinces of West Papua, Southeast Sulawesi, and South Sulawesi.

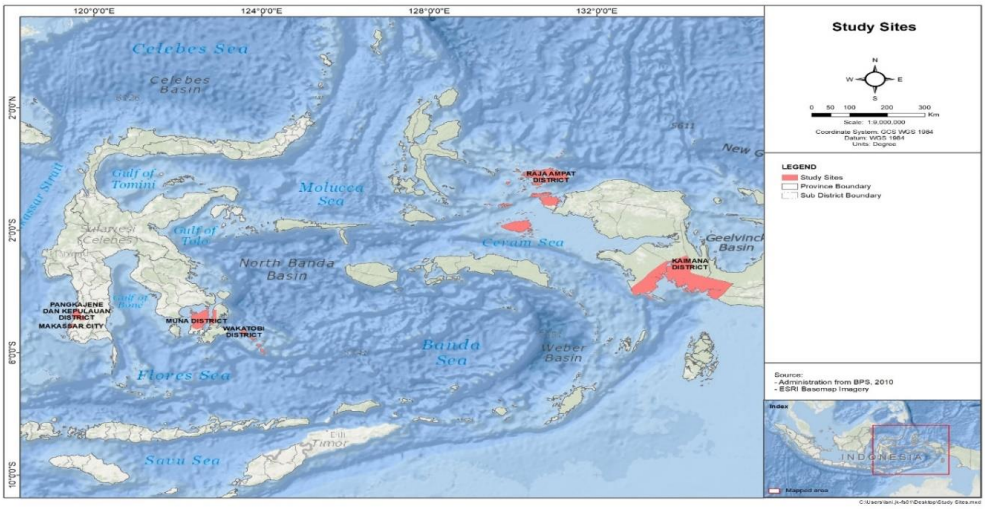

Fig. 1. Map of the study sites of COREMAP and Control areas. COREMAP districts consist of Pangkajene dan Kepulauan, Wakatobi, and Raja Ampat District. Control districts consist of Makassar, Muna and Kaimana District. The study sites located in Eastern Indonesia. (Source: Administration from BPS, 2010)

Sample respondents

Respondents of the survey were chosen randomly from the village fisher households in three COREMAP and three control districts (Table 2). About 100-133 fishers were interviewed from each district proportionately in the identified villages. A total of 684 respondents made up the household survey for both the control and treatment areas from 35 villages consisting of 167 COREMAP beneficiaries, 193 non-COREMAP beneficiaries and 324 control fishers. In this study, COREMAP beneficiaries refer to fishers who are receiving both technical and financial assistance from the project while COREMAP non-beneficiaries refer to fishers who are not receiving any assistance but live within the COREMAP areas. Respondents in the control area refer to fishers who live outside the COREMAP areas.

Table 2. Sample respondents in both sites, East Indonesia, 2016

Province	Location			Total
	COREMAP beneficiaries	COREMAP non-beneficiaries	Control	
West Papua	79	37	115	231
Southeast Sulawesi	11	122	109	242
South Sulawesi	77	34	100	211
Total	167	193	324	684

Impact evaluation

Impact evaluation can define the difference between outcomes for those with a program and those without it. The outcome of post-intervention with the program can be observed, but not the outcome in the absence of the program (i.e., the counterfactual). It is also able to explore unintended consequences, either having a positive or negative impact on beneficiaries [14]. Therefore, the need for a counterfactual group is overcome by establishing a credible comparison group.

There are two methodologies to determine the counterfactual: experimental design (randomized) and quasi-experimental design (non-randomized). The experimental design is often known as randomization and is generally considered as the most robust of the evaluation methodologies. However, this method is very expensive and time-consuming particularly in the collection of new data [14]. While quasi-experimental design (non-randomized) is used when there is no possibility to construct treatment and comparison groups through experimental design.

Several studies used quasi-experimental design for impact evaluation of a newly implemented program [15-19]. One such design is propensity score matching (PSM) which is used in this study to estimate the difference in outcome between fishers in COREMAP and fishers in control areas and between COREMAP beneficiaries and non-beneficiaries. The beneficiary's group (COREMAP) and the counterfactual group (non-COREMAP) should be as similar as possible in all characteristics. The outcome indicators used in the analysis were basic income as fishermen, number of fish catch, non-fishing income (alternative income), and household income. The predicted value of the logit model was (refer Equation 1) to estimate the propensity score for each observation in both areas and data analysis was made using the Stata software.

The logit model used in this study is as follows:

$$P(X_i) = \Pr ob(D = 1 \mid X_1, X_2, ..., X_K) \ (0 < P(X_i) < 1) \quad (1)$$

where:

P(Xi) = the propensity score

D = binary variable [1=under COREMAP program, and 0= otherwise]

Xi = background characteristics variables (age of household head, age of housewife, educational level of household head, educational level of a housewife, and experience (in years) as a fisherman)

After obtained the predicted probability propensity score for both treatment and control groups, matched the coefficient of propensity based on the background characteristics included in the independent variables. This study used (1) Nearest neighbor (NN); (2) Radius matching; (3) Stratification and interval matching; (4) Kernel and local linear matching as commonly used matching methods and recommended by Li [20] which had been shown to produce reliable estimates of the average treatment effect (ATT).

Lastly, the average treatment effect (ATE) or the difference between the outcomes of treated and control observations were estimated as:

$$\Delta Y = Y_1 - Y_0$$

$$ATE = E(\Delta Y) = E(Y_1 \big| X, D = 1) - E(Y_0 \big| X, D = 0) \quad (2)$$

The equation above is only appropriate for a random experiment. However, in observational studies, it will be biased if the treated and control observations are not similar, in other words, different X characteristics from control observations. Due to different characteristics of control, the average treatment effect on the treated (ATT) is needed to avoid this bias [21]. ATT is defined as the difference between the outcomes of treated and the outcomes of the treated observations if they had not been treated. ATT can be expressed as:

$$ATT = E(\Delta Y \big| D = 1) = E(Y_1 \big| X, D = 1) - E(Y_0 \big| X, D = 1) \quad (3)$$

The second term in the equation is a control observation and not observable and needs to be estimated. Hence, the ATT with the new control observations after matching on propensity score and given that both un-confoundedness and overlap conditions hold, and the PSM estimator for the average treatment effect on the treated (ATT) can be expressed as:

$$ATT = E(\Delta Y \big| P(X), D = 1) = E(Y_1 \big| P(X), D = 1) - E(Y_0 \big| P(X), D = 0) \quad (4)$$

ATT can also be denoted as follows:

$$ATT = \frac{1}{N} \sum_{i[G_i=1]} \left(Y_1 - \sum_{j[G_i=0]} \theta(i, j) Y_{0j} \right) \quad (5)$$

where: N is the number of the households who belong to the COREMAP program, $\{G_i = 1\}$ is the set of COREMAP member households, $\{G_j = 0\}$ is the set of non-COREMAP households, and $\theta(i, j)$ is a weighted value for each non-member household that depends on the matching method (i and j). Note that $\sum_{ji(G_j=0)} \theta(i, j) Y_{0j}$ is the estimate of the counterfactual income of COREMAP member household i.

Results and discussion

Results

Table 4 shows the mean values of both treatment (beneficiaries and non-beneficiaries) and control are almost similar. For instance, the average age of household head ranged between 39-42 years old, with household heads in the treatment sites younger than in the control sites. The average age of housewife in both sites ranged between 34-35 years old. Both households' heads and housewives had the same educational level (i.e. finished in elementary school) in both treatment and control sites. The fishing experience is between 20-23 years, with treatment households (beneficiaries) having almost the same fishing experience with control households. Engine powers of motorized boats are used between 12–16 horsepower (hp) and both sites had one fishing boat.

Educational attainment of them was generally low, with both household head and wife finishing only elementary education but had long fishing experiences between 20-23 years.

Engine power of motorized boats used in fishing was generally below 16 horsepower and most fishers in the COREMAP had only one fishing boat.

Table 3. Socio-economic characteristics of fisher-respondents in both areas, 2016

Characteristics	COREMAP						Control		
	Beneficiaries			Non-beneficiaries					
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
No. family members	4.41	1	9	4.16	1	10	4.43	1	10
Age of HH head	39.33	18	70	39.17	19	70	41.91	20	70
Age of housewife	34.18	18	65	35.13	18	80	35.50	19	65
Education of housewife	1.39	0	4	1.19	0	4	1.18	0	4
Education of housewife	1.30	0	4	1.13	0	4	1.13	0	4
Fishing experience	22.88	3	69	19.65	2	50	22.25	1	55
Engine power	0.16	0	1	0.15	0	1	0.12	0	1
Number of boats owned	1.09	1	3	1.03	0	3	1.01	1	2

Source: Household Survey, 2016

Source of alternative livelihoods

Non-fishing income sources of both fishers as COREMAP beneficiaries and non-beneficiaries are listed in Table 5. Non-beneficiaries are also benefitting from COREMAP activities as a spillover effect of project implementation. This is explained by the higher proportion of non-fishing income than fishing income (Table 6) and some alternative livelihood introduced by COREMAP for both beneficiaries and non-beneficiaries. Generally, fishers in COREMAP areas in both groups earn additional income from seaweed farming (14%), the handmade crafting of the fishing net by women (11%), homestay operation (10%), handicraft making (10%), tourist guiding (7%), diving and snorkeling operations, farming, constructions, and others.

Table 4. Non-fishing income sources in COREMAP areas (N = 281) in East Indonesia

Type of income sources	Beneficiaries		Non-beneficiaries		Both	
	Freq	%	Freq	%	Freq	%
Homestay operator	17	11.26	12	9.23	29	10.32
Handicraft making	20	13.25	9	6.92	29	10.32
Hand-made Fishing net	24	15.89	7	5.38	31	11.03
Diving operator	8	5.30	4	3.08	12	4.27
Snorkeling operator	1	0.66	-	-	1	0.36
Tourist guide	12	7.95	7	5.38	19	6.76
Seaweed farming	21	13.91	18	13.85	39	13.88
Farming	5	3.31	9	6.92	14	4.98
Sari-sari store	8	5.30	4	3.08	12	4.27
Construction	1	0.66	1	0.77	2	0.71
Others	34	22.52	59	45.38	93	33.10
Total	151	100.00	130	100.00	281	100.00

Source: Household Survey, 2016

Impact of COREMAP on people's income

The results show that the income sources of both beneficiaries and non-beneficiaries in COREMAP areas were mainly generated from non-fishing income (Table 6). The COREMAP beneficiaries had the highest average household income compared to non-beneficiaries and control. However, the fishing income of COREMAP beneficiaries is the lowest compared to others. Their loss in fishing income was offset by higher income from other sources (non-fishing income) such as tourism. Unlike in control areas, fishers mostly depend on income from fishing (54%) than other sources (46%). COREMAP has contributed to reducing poverty by

bridging people in COREMAP villages to transform from being fishing-dependent to engaging in tourism activities which are more profitable and sustainable. Catching fish is no longer a main source of income in some villages. Many people catch fish only for household consumption and food needs of homestay guests. Some villages, however, still rely on fishery resources as income source although they are progressing toward village tourism. However, all fishing activities are under control and sustainable.

Table 5. Income proportion (IDR/month) of fishers in both COREMAP and control sites

Fishers Status	Household income (mean)	%	Fishing income (mean)	%	Other income sources (mean)	%
COREMAP						
Beneficiaries	4,684,911	100	1,388,884	35	3,296,027	65
Non-Beneficiaries	3,976,631	100	1,411,338	41	2,565,293	59
Control	3,115,749	100	1,619,797	54	1,495,952	46

Note: 1 USD = IDR 13,500

For the matching method, Table 7 shows the results of the average different effect of fishers' participation in COREMAP. Two groups were analyzed, namely, 1) COREMAP fishers, attributed to all fishers who live in the COREMAP areas, and 2) COREMAP beneficiaries referring to fishers who are involved in COREMAP activities and received technical and financial assistance provided by COREMAP project. Four outcome indicators were analyzed; (1) number of fish catch per month; (2) fishing income per month; (3) non-fishing income per month; (4) total household income per month.

The first outcome indicator is the fish catch. The average difference in fish catch per month in groups of COREMAP vs. control is negative and significant at the 10% probability level. This result prevails in all matching methods used and means that fishers in COREMAP areas have lower catches than in control areas. Even among COREMAP beneficiaries vs. non-COREMAP beneficiaries, the average catch difference is also lower (except using NN matching) but not significant. Consequently, this affects fishing income becoming negative for both groups. This result implies that COREMAP project succeeded to reduce fishing pressure in COREMAP area. Moreover, the average difference in fish catch and fishing income for fishers as COREMAP beneficiaries is higher than non-COREMAP beneficiaries.

Low fish catch of COREMAP fishers compared to control may indicate that COREMAP was successful in controlling the amount of fish catch in COREMAP areas. COREMAP fishers exerted less effort in catching fish due to restrictions in the fishing area and limited fishing gears allowed in COREMAP sites. Also, this may suggest that COREMAP project could have reduced fishing pressure or dependency with alternative livelihood as introduced in COREMAP areas, and increased people's awareness through COREMAP to preserve their marine resources by not exploiting more fish.

On the other hand, the non-fishing income as the third outcome shows a positive impact of the COREMAP project. Loss of fishing income was compensated for by other income sources in COREMAP areas. Besides, the average difference in income of COREMAP beneficiaries is higher than non-beneficiaries, implying that alternative livelihood for additional income introduced by COREMAP project was successful in reducing fishing pressure. The fishers in COREMAP areas did not depend only on fishing income but were able to generate alternative income from such activities as seaweed farming, homestay operating, diving and snorkeling operations, tourist guiding, handicraft making, weaving, culinary arts, and even fish processing. These activities, however, did not exist in control sites. As a result, the total household income (as a sum of fishing income and non-fishing income) shows positive values for all matching methods used in both COREMAP vs. control and COREMAP beneficiaries vs.

non-beneficiaries (Table 7 and 8). This finding indicates that interventions introduced by the COREMAP project have helped improve fishers' livelihoods in COREMAP areas.

Table 6. The average effect of fishers' participation in COREMAP project on people's income, COREMAP vs. control, 489 fishers' household, East Indonesia, 2016

Outcome indicators	Before matching	NN matching	Radius matching	Kernel matching	Stratification matching
Fish catch (Kg)	-15.45*	-24.74*	-19.94*	-14.63*	-15.03*
T-value	-2.06	-2.32	-1.90	-2.05	-2.01
Fishing income (IDR)	-209,529 NS	-506,341*	-306,718	-245,879 NS	-211,447 NS
T –value	-1.32	-2.52	-1.28	-1.56	-1.25
Non-fishing income (IDR)	1,451,524***	1,533,765***	1,329,753**	1,502,182***	1,367,973***
T –value	4.41	4.85	2.71	5.33	4.84
Household income (IDR)	1,241,994**	1,027,424**	1,023,034*	1,256,303**	1,156,526**
T –value	3.04	2.95	2.23	3.10	2.85

Note: *, **, and *** denote statistically significant at 10%, 5% and 1% levels, respectively
NS is not significant at 10% probability level.

Table 7. The average effect of fishers' participation in COREMAP project on people's income, beneficiaries vs. non-beneficiaries, 280 fishers' households, East Indonesia, 2016

Outcome indicators	Before matching	NN matching	Radius matching	Kernel matching	Stratification matching
Fish catch (Kg)	-10.37NS	1.03 NS	-8.96 NS	-8.38 NS	-11.62 NS
T-value	-1.26	0.10	-0.31	-1.10	-1.25
Fishing income (IDR)	-22,454 NS	31,014 NS	-50,952 NS	-85,785 NS	-71,188 NS
T –value	0.10	0.10	-0.08	-0.37	-0.30
Non-fishing income (IDR)	730,733 NS	838,399 NS	111,524 NS	726,596 NS	566,422 NS
T –value	-1.33	0.97	0.07	1.16	0.96
Household income (IDR)	708,279 NS	869,414 NS	60,572 NS	640,811 NS	495,234 NS
T –value	1.05	0.82	0.03	0.88	0.77

Note: NS denotes not significant at 10% probability level.

Discussion

Indonesia's small-scale fishers are very dependent on fisheries in terms of food security for nutrition intakes and livelihood source for daily needs. Most of the small-scale fishers fall into the high level of poverty category. According to *Cahagi D and Gurning R* [22] study, 22 percent of the coastal village's population rely on fisheries for their main source of income. However, the average fisher income was lower compared to the provincial minimum wage, which was around 65 percent in 2013. There are some reasons why low income received by small-scale fishers, among others are (i) insufficient technical and management skills; (ii) restricted access to finance; (iii) limited access to markets; (iv) limited access to technology; and (v) limited basic infrastructure and facilities to support diversified opportunities.

Mizrahi *et al* [4] highlight many studies have done with the absence of robust analysis in assessing the impact of MPA on the socio-economic aspect. The study notes that understanding of socioeconomic factors as the result of positive MPA impact is critical to the MPA planning process. The results of the evaluation are useful to emphasize the movement of MPA management, identifying and setting up the priorities of future actions for management, and ensuring accountability for better management policies and practices [23]. Therefore, developing indicators to assess MPAs achievement is important to measure the goals and

objectives are met. Pomeroy *et al* [23] define the three primary aspects when evaluating the MPAs including governance, biophysical condition, and socioeconomic condition. In this study, we focus evaluating the MPAs within the COREMAP program on socioeconomic aspect condition as this aspect has a direct influence on MPAs operation such as the livelihood source determine which type of species or are most harvested.

Conservation program such COREMAP is often facing a trade-off between its purpose to increase the biophysical condition, and at the same time willing to attract the local economy. Mizrahi *et al* [4] argue that by focusing marine conservation impact from only ecosystem-based perspective may lead to disregarding the coastal community. Conversely, focusing on livelihood impacts of the coastal community could neglect to allocate the marine conservation areas that will benefit the surrounding ecosystems including the human being. Conservation approach that pursues to avoid all impacts on the coastal community is likely to fail to avoid negative outcomes for ecosystems as resource-dependent livelihoods possibly causing in a destructed and illegal fishing activities [24].

People's awareness of the conservation program

Prior to implementing COREMAP, there was a consensus meeting involving all COREMAP community members in the study sites, however, it was discovered that women in fishing households who attended in the focus group discussion were not involved. Some people in the COREMAP villages understood while some of them were unaware of the goals of COREMAP project in their villages. There are benefits of the presence of COREMAP conservation program and among others are providing knowledge on the importance of coral reefs for coastal and marine biodiversity, benefiting all through sustaining the marine and fishery resources in the area, and providing capacity building for marine conservation activities. Moreover, COREMAP provides its benefit to protect the marine and fishery resources through implementing group monitoring, control and surveillance, and build the capacity of women community in fish processing and seaweed production as sources of alternative income. The community members of COREMAP also understood that COREMAP program also supports infrastructure development in the village such as establishing a sea dike against big waves along the coastal line and other infrastructures.

The COREMAP project was generally accepted by the coastal community despite the fact that some of them did not receive any form of assistance from the program. In West Papua (Raja Ampat) for instance, people actively support the COREMAP activities as they recognized that the COREMAP goals are in line with their traditions to protect their sea and land, a concept of temporary fishing closure known locally as 'sasi'- a traditional way to protect and preserve marine resources for the public good in Raja Ampat. People are strictly prohibited from taking fish within a designated area during sasi or carrying out destructive activities in the marine ecosystem. The sasi area is about 4km from the coastline and size of this closure area varies from one island to another. No taking of fish during the closed season was imposed to allow fish to reproduce or breed to sustain fish productivity. Sasi prevailed for two years and the designated area is open to harvest usually for one month after which it is again closed to harvesting.

Years ago, before the COREMAP project existed, many problems occurred related to illegal fishing and destructive fishing activities such as the use of small mesh size (e.g. 6mm) of fishing nets that catch small or juvenile fish, dropping anchors that damaged the coral reef, blast fishing, and bottom trawling. Both local fishermen and outsiders (or non-resident fishers) commonly used bombs and cyanide to catch fish which caused widespread damage to the coastal ecosystem. These unsustainable actions resulted in a decline in the diversity and abundance of fish and other marine life. Sadly, coastal communities were unaware that their activities would destroy the source of livelihood for many people in the area. After the

COREMAP project was implemented and people got better information, those activities were gradually reduced and presently no longer occur in the project areas.

To broaden public education, COREMAP collaborated with a local radio network in spreading information on its conservation activities. The radio program regularly reported about how the coral reefs benefit fishers and people. With the tagline "healthy coral reefs make fish abundant and increase people's welfare", this program was able to reach most people in small islands who have radios for accessing news and entertainment.

COREMAP succeeded in reducing fishing pressure

From the three indicators measured (Table 6), the results of the first indicator indicate negative fishing income for both groups and associated with a low fish catch. Low fish catch of COREMAP fishers compared to control may indicate that COREMAP is successful in controlling the number of fish catch in COREMAP areas. COREMAP fishers exerted less effort in catching fish due to restrictions in the fishing area and limited fishing gears allowed in COREMAP sites. Besides, this may suggest that COREMAP II project able to reduce fishing pressure and increased people's awareness to preserve their marine resources. Consequently, this has reduced fishing income in COREMAP areas. This result implies that COREMAP project succeeded to reduce fishing pressure in COREMAP area. Moreover, the average difference in fish catch and fishing income for fishers as COREMAP beneficiaries is higher than non-COREMAP beneficiaries.

For the second indicator, the non-fishing income shows the positive impact of the COREMAP project. Loss of fishing income is compensated by other income sources in COREMAP areas i.e. alternative income from seaweed farming, homestay operating, diving and snorkeling operations, tourist guiding, handicraft making, weaving, culinary arts, and even fish processing. These activities, however, did not exist in control sites.

For the third indicator, the total household income (as a sum of fishing income and non-fishing income) indicates positive values for all matching methods used in both COREMAP vs. control and COREMAP beneficiaries vs. non-beneficiaries. This finding indicates that interventions introduced by the COREMAP project have helped to improve fishers' livelihoods in COREMAP areas. COREMAP has contributed to reducing poverty by bridging people in COREMAP villages to transform from being fishing-dependent to engaging in tourism activities that are more profitable and sustainable. Catching fish is no longer a main source of income in some villages. Many people catch fish only for household consumption and food needs of homestay guests. Some villages, however, still rely on fishery resources as income source although they are progressing toward village tourism. However, all fishing activities still under control and sustainable.

Conclusions

Overall, COREMAP succeeded in reducing the fishing pressure of the natural resource base. Concerted efforts in protection and conservation obtained the positive impact of COREMAP II program on livelihoods of coastal communities. It should be noted that not all fishers received technical and financial assistance from COREMAP II due to limited budget, except in West Papua (Raja Ampat) which has a small fisher population. For those who did not receive any technical and financial assistance, conservation activities in COREMAP areas created a spillover effect resulting in a positive impact on other fishers and villagers. For instance, surveillance activities and patrolling by COREMAP group reduced the destructive activities in the area and consequently the benefits were also enjoyed by non-COREMAP beneficiaries in the villages.

Beneficiaries are particularly better off than non-beneficiaries and control sites in terms of higher household income and non-fishing income on-site monitoring data. Beneficiaries also received other forms of assistance to divert the community from fishing activities. The project encouraged the communities to engage in other livelihood activities such as processing of fish products and provided revolving funds or seed capital for households to engage in other businesses that suit their area best. Results from this study support the COREMAP II reports (2012) which stated that the communities' welfare increased about 10-15% over the years of the project.

It is suggested that a marine conservation project like COREMAP that contributes to the sustainability of marine and fishery resources is a worthy investment. It is seriously implemented by the government to enforce regulations on illegal and destructive fishing practices and their effect on reducing marine biodiversity. The focus of livelihood support in reducing pressure on coastal resources appears to be an effective strategy in the sustainability of coastal resource management. Moreover, the management community unit established by COREMAP plays a crucial role in conserving coastal and marine resources in the project sites. Hence, there is so much incentive for continuing COREMAP's initiatives.

Conservation is an important fishery management tool that regulates the manner by which human society utilizes abundant yet vulnerable fishery resources. The success of conservation efforts under COREMAP rests on an ecological approach to fishery resource management.

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