Marine Policy 86 (2017) 173–181

Contents lists available at ScienceDirect

Marine Policy

journal homepage: www.elsevier.com/locate/marpol

The impact of community-based fisheries management (CBFM) on equity and sustainability of small-scale coastal fisheries in the Philippines

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A B S T R A C T

It was realized that with the increasing rate of deterioration of fisheries resource in the Philippines, there was no way the country could pursue a pathway of sustainable development. After enactment of the Local Government Code of 1991, the government actively promoted community-based fisheries management (CBFM) to conserve the coastal resources. The increased attention paid to community-based fisheries management has come about through experience of the poor performance of other approaches and through the study of traditional systems of community management of natural resources which have not only survived but also appear to perform better than the alternatives. This paper presents the results of a study to assess the impacts of CBFM projects in the Philippines, using meta-analysis, on the equity and sustainability of small-scale coastal fisheries. The outcomes indicate a positive impact of CBFM on the equity of both involvement in management and benefit sharing and sustainable management of fisheries resources through the investigation of effective magnitude (effect size) based on eight indicators. The positive summary effect sizes of *participation*, *influence*, *control*, *access*, and *income* conjunctly portrayed an improved equity in the fishing community by implementing CBFM. The positive summary effect sizes of *compliance* and *conflict* indicated an affirmative community and, therefore, sustainable fisheries management. While the negative summary effect size of *resource* revealed the difficulties in recovering fish abundance in a relatively short period of time. Also, ten years of implementation of CBFM was discovered as the minimum duration with perceived equity and sustainability improvement for most indicators.

1. Introduction

During the late 1980's in the Philippines, there was a decreased rate in coastal fish production of 1.3% a year, compared to the increasing rate of 6.1% in the preceding five years from 1979 to 1983 [1]. The problems in the fishery continued to worsen throughout the late 1980s and early 1990s [2–5]. The management (mainly through regulatory instruments) and development (increased fishing effort) measures undertaken by the government (Bureau of Fisheries and Aquatic Resources) were ineffective in promoting the sustainable management and development of the country's fisheries. It was realized that with the increasing rate of deterioration of natural resource systems in the Philippines, there was no way the country could pursue a pathway of sustainable development. In the Philippines, critical issues affecting fisheries include: open access; overfishing and excessive fishing pressure; inadequate management; inappropriate exploitation patterns; post-harvest losses; small- and large-scale fisheries conflicts; habitat degradation; lack of research and information; and inadequacy of technical and human resource capabilities, particularly among managers and the agencies concerned in analyzing fisheries.

The transition of fisheries management, from stock and species-based harvest-orientated top-down legal mandates of the 1970s and 1980s to ecosystem and community-based conservation orientated management (Table 1), have been increasingly recognized and widespread [6,7].

After enactment of the Local Government Code of 1991, it was realized, that the local government was needed as a partner to provide legal and enforcement support for the community resource management and marine protected areas. Through several initiatives, the government actively promoted devolution and community-based fisheries management and co-management efforts to conserve the coastal resources and diversify the income sources of the low-income small-scale fishers. The new approach highlights the capability of local resource users by participatory planning and implementation as well as

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http://dx.doi.org/10.1016/j.marpol.2017.09.027
Received 12 July 2017; Received in revised form 21 September 2017; Accepted 23 September 2017
Available online 01 October 2017
0308-597X/

Table 1
Fisheries management transition in the Philippines.

	1950s-1960s	1970s-1980s	1990s-Present	
Demand does not surpass supply	Coastal resource development promoted by national government	Regulation of coastal resources instituted by national government	National legal and policy framework for coastal management established	Coastal management devolved to the local government as a basic service
	Fishers exploit coastal resources with open access	Community-based resource management models developed	Community-based resource management institutionalized	
	Harvest-orientated →			Conservation-orientated

decentralization of the management authority and responsibility to the local level [7]. The increased attention paid to community-based fisheries management (CBFM) has come about through experience of the poor performance of other approaches and through the study of traditional systems of community management of natural resources which have not only survived but also appear to perform better than the alternatives [8]. Compared with other countries in the world, the Philippines has the most number of the CBFM projects and programs. To date, well over 1000 CBCRM projects have been implemented by government, NGOs, fishing communities and academic and research institutions. No country in the world has that range of experience with CBCRM in the Philippines [9]. With extensive input of time and money, as well as the collective efforts of different communities, organizations, and institutions, a great deal of experience and knowledge about CBFM has been derived and accumulated during the implementation of the projects and programs. It would be a waste if all these experiences were only useful to their own implementation. Moreover, they deserve to be a generator of deeper understanding and valuable knowledge as guidance for future participants and implementers of similar projects and programs. Although there are some fairly comprehensive studies on the CBFM projects and programs in the Philippines, they were studies which either focused on one project or program at a time or presented as a descriptive synthesis [1,10,11]. Unfortunately, they did not present general effects sizes and their pattern during the implementation and lack the ability to reveal the true effect differences (population variability) and their magnitude of such projects and programs.

This paper provides a critical assessment of the impacts of completed CBFM projects and programs (31 sites of 13 projects and programs) on sustainability and equity issues [12] and serves as a basis for improving planning and implementation of further projects in the Philippines by using meta-analysis and meta-regression [13]. The specific objectives of this paper are: (1) describe the characteristics of projects and programs of CBFM in the Philippines; (2) assessing the impacts of CBFM projects and programs on sustainability of both fisheries resource and management, as well as the equity of both involvement in management and benefit sharing in fishing communities, in both magnitude and heterogeneity dimensions; and (3) identify the determining factors for the sustainability and equity of CBFM.

2. Materials and methods

2.1. Project selection and data collection

The selection of projects and programs to be included for quantitative analysis in this study, required several criteria to be met: (1) projects and programs that targeted coastal fisheries; (2) the main approach is community-based fisheries management; (3) a household perception survey of fisheries management and fishers' livelihood before and after the project or program is accessible; (4) the duration of a single project or program must be more than (or equal to) three years for a better presentation of the impacts on both fisheries resource and fisher's livelihood. A quasi-experimental with difference-in-difference (DID) concept [14,15] was used with a slight tweak for the projects and programs assessment to counteract factors that might have impacts upon certain indicators even if there had been no intervention at all; and (5) Thus, other than the "treatment group", which included the members of the CBFM, a "control group", which was chosen on one site in each study, it differed from treatment groups as fishing activities were not organized by CBFM.

After searching various secondary literature including project reports, evaluation documents, publications, scientific journal articles, workshop papers and conference proceedings, 31 site studies of 13 projects and programs across 20 provinces in the Philippines were selected and included in this study (Fig. 1 and Table 2). Respondents (same number of randomly picked members and non-members of CBFM) were asked questions before and after the interventions, about perceptions of community organizing, and the well-being of fisheries resources and household livelihoods. More indicators were available in some projects or programs, but due to the requirement of common indicators in the meta-analysis, with the average sample size of 93.16 for each site study (including both treatment group and control group), eight common indicators (Table 3) were extracted from all 13 projects and programs. Most chosen projects and programs as well as the indicators employed the existing survey framework described by Pomeroy and others [9], which was also employed by many researchers in studies of the Philippines [11,16–18]. For other projects and programs that did not employ this framework, the data could be standardized accordingly for proper comparison.

2.2. Meta-analysis

It worth mentioning that the meta-analyses [19] applied to this study included: (1) generation of the summary effect sizes (weighted effect size) of each indicator across all projects and programs for quantifying the directions and magnitudes of the impacts of CBFM [20,21], (2) meta-regression for revealing the relation between summary effect sizes and characteristics of fishing households; and (3) categorical analysis for identifying the critical years of intervention with a statistical significant increase in summary effect size of each indicator [22].

2.2.1. Effect sizes

The effect sizes used in this study were constructed in the form of response ratio which quantifies the proportionate change as a result of

Fig. 1. Selected community-based fisheries management (CBFM) projects and programs in the Philippines.

Table 2
Projects and programs included in the meta-analyses.

	Projects & Programs	Funder	Period	Projects site(s)	Sample Size
1	Central Visayas Regional Project − 1 (CVRP − 1)	ICLARM	1984–1992	Ayungon, Badian, Ronda, Bais Bay	260
2	Coastal Environment Program (CEP)	ICLARM	1993–1996	Ulugan Bay, Sagay, Bais Bay, Mabini-Tingloy	122
3	Honda Bay Resource Management Project	ICLARM	1988–1990	Honda Bay	54
4	Coastal Resource Management Project (CRMP)	OIDCI, USAID	1996–2000	Cordova, Bais Bay, Buenavista,Malapatan, San Vicente	160
5	Fisheries Sector Program (FSP)	ADB	1989–1992	Panguil Bay	442
6	Marine Conservation Project	ICLARM	1989–1993	Masinloc	42
7	Community Fisheries Resource Management Project	IDRCC	1995–1996	Culasi	42
8	Canadian International Development Agency-Local Government Support Program	ICLARM	1996–2002	Banate Bay	60
9	Balayan Bay Integrated Coastal Management Project	WWF, KKP	1990–2005		60
10	Fisheries Co-management Research Project	ICLARM	1988–1998		106
11	Sustaianable Rural District Development Program	SNV	1994–1998		76
12	Fisheries Resource Management Project	ADB	1998–2006		504
13	Mindanao Rural Development Program	World Bank	2000–2014		960

Table 3
The common indicators used to assess the impacts of CBFM in the Philippines.

Indicators (Mean)	Definition
Participation	the level of involvement in fisheries management
Influence	the level of bargaining power over decisions made related to fisheries management
Control	the sense of influence to monitor and regulate the internal use pattern of fisheries
Compliance	the level of conformity of behaviors with prescribed operational rules and regulations
Conflict	competitiveness and promptness in resolving disputes related to fisheries resource use
Access	the level of fair allocation of entering and withdraw fisheries resource
Income	all the revenues received by a family labor in one year
Resource	the overall well-being of fisheries resource

the interventions [20]. The natural logarithm transformation of response ratio was applied in the meta-analyses due to its better statistical performance [23]. Furthermore, the difference in control group (before and after preception of non-members) was integrated as a modification to the original response ratio as the effect size in this paper [20,21,23] for limiting the influences that were not caused by projects or programs but affect the indicators.

$$\ln(RR_{ij}) = \ln\left[\frac{\overline{X^a_{t\,ij}}}{\overline{X^b_{t\,ij}} + (\overline{X^a_{c\,ij}} - \overline{X^b_{c\,ij}})}\right] \tag{1}$$

where $\overline{X}$ is the perception mean of each indicator, t and c indicate the different groups (treatment and control), a and b indicate different time points (after and before the intervention), i and j indicate the number of indicators and the number of projects or programs, respectively. (e.g. $\overline{X^a_{t\,ij}}$ stands for the mean of indicator i in the treatment group of projects j after the intervention.)

For obtaining the most precise (minimal variance) estimate of summary effect size for each indicator across all projects and programs, weight (w) was assigned to each program or project for every indicator, which was defined as the inverse of the sample variance (v) of its mean score in each program or project. The sample variance v_{ij} was estimated by an asymptotic distribution based on the sample size and standard deviation of before and after project survey for both treatment and control groups [24] as shown

$$v_{ij} = \left(\frac{1}{\overline{X^a_{t\,ij}}}\right)^2\left[\frac{(SD^a_{t\,ij})^2}{N^a_{t\,j}}\right] + C_{ij} \tag{2a}$$

$$C_{ij} = \left(\frac{1}{\overline{X^a_{t\,ij}} + \overline{X^a_{c\,ij}} - \overline{X^b_{c\,ij}}}\right)^2\left[\frac{(SD^b_{t\,ij})^2 + (SD^a_{c\,ij})^2 - (SD^b_{c\,ij})^2}{N^b_{t\,j}}\right] \tag{2b}$$

where N and SD are the sample size and standard deviation of the household survey, respectively, also $N^a_{t\,j} = N^b_{t\,j} = N^a_{c\,j} = N^b_{c\,j}$, a and b signify the time points of (after and before) project or program, i and j stand for the specific indicator and which project or program it is in.

The random-effects model proposed by DerSimonian and Laird [25], which incorporates two parts of variance (between study & within study variance) was used in this study [20,21,26]. Thus, the total variance in each program or project is the summation of both variances as,

$$V_{ij} = v_{ij} + \tau_i^2 \tag{3}$$

For the between-study variance, DerSimonian and Laird's method [25] was employed, and the calculation was shown as,

$$\tau_i^2 = \frac{Q_i - (k-1)}{\sum_{j=1}^{k} w_{ij} - \frac{\sum_{j=1}^{k} w_{ij}^2}{\sum_{j=1}^{k} w_{ij}}} \tag{4}$$

$$Q_i = \sum_{j=1}^{k} w_{ij}[\ln\,(RR_{ij})]^2 - \frac{\left[\sum_{j=1}^{k} w_{ij}\ln\,(RR_{ij})\right]^2}{\sum_{j=1}^{k} w_{ij}} \tag{5}$$

where k is the number of projects and programs.

To determine whether the effect size of each indicator across projects and programs was consistent, the heterogeneity test using Q statistic was applied, and the I^2 statistic could provide the magnitude of that heterogeneity if it existed [27]. Further, meta-regression and categorical analysis were conducted to reveal and quantify the causes for the heterogeneity. Then, we were able to compute the total variance for each effect size in each project using Eq. (6) as well as the weight assigned to each study under random-effects model. Finally, the summary effect size (weighted mean effect size) and its variance for each indicator across all projects and programs under the random-effects model was calculated in Eqs. (9) and (10) respectively.

$$\overline{\ln\,(RR_i)} = \frac{\sum_{j=1}^{k} W_{ij}\ln\,(RR_{ij})}{\sum_{j=1}^{k} W_{ij}} \tag{6}$$

$$V_{\overline{\ln\,(RR_i)}} = \frac{1}{\sum_{j=1}^{k} W_{ij}} \tag{7}$$

Instead of deriving standard error of summary effect size for each indicator by simply taking the square root of its variance of the weighted mean calculated in (10), Hedges and others [23] proposed a more accurate estimate with small sample bias correction as shown below,

$$SE_{\overline{\ln\,(RR_i)}} = \sqrt{\frac{1}{\sum_{j=1}^{k} W_j}\left\{1 + 4\sum_{i=1}^{k}\frac{1}{df_i}\left(\frac{W_i}{w_i}\right)^2\frac{W_i\left[\left(\sum_{j=1}^{k} W_j\right) - W_i\right]}{\left(\sum_{j=1}^{k} W_j\right)^2}\right\}} \tag{8}$$

where df_i is the number of degrees of freedom in the *ith* study.

With standard error estimated, the confidence interval (95%) of summary effect size in random-effect model for each indicator was calculated as shown,

$$LB_{\overline{\ln\,(RR_i)}} = \overline{\ln\,(RR_i)} - 1.96{*}SE_{\overline{\ln\,(RR_i)}} \tag{9a}$$

$$UB_{\overline{\ln\,(RR_i)}} = \overline{\ln\,(RR_i)} + 1.96{*}SE_{\overline{\ln\,(RR_i)}} \tag{9b}$$

2.2.2. Meta-regression and categorical analysis (subgroup meta-analysis)

Meta-regression majorly focused on seeking the relation between the characteristics of fishing households (independent variables) and summary effect size (dependent variable) of each indicator that was calculated from the random-effects model. Also, the categorical analysis was carried out for each effect size to determine whether they were impacted differently by the duration of the intervention. Considering the budget constraint that any government, NGO, or private agency has to encounter, the most efficient and effective years of CBFM project or program was rarely discussed in the past. In this study, projects and programs were categorized into two groups with different duration (Table 2) of CBFM intervention of each project or program (e.g. less than 8 years and more or equal than 8 years) and categorical analyses were then carried out for each indicator using the Q_{btw} statistic as shown below, it used to test the null hypothesis that the weighted mean of distribution of effect sizes are the same for two groups.

$$Q_{btw} = \sum_{g=1}^{c}\sum_{p=1}^{n_g} w_{pg}[\ln\,(RR_{pg})]^2 - \frac{\left[\sum_{p=1}^{n_g} w_{pg}\ln\,(RR_{pg})\right]^2}{\sum_{p=1}^{n_g} w_{pg}} \tag{10}$$

where g is the number of groups ($g = 2$ in this study), n_g is the number of projects and programs in the group g, $\ln\,(RR_{pg})$ stands for the effect

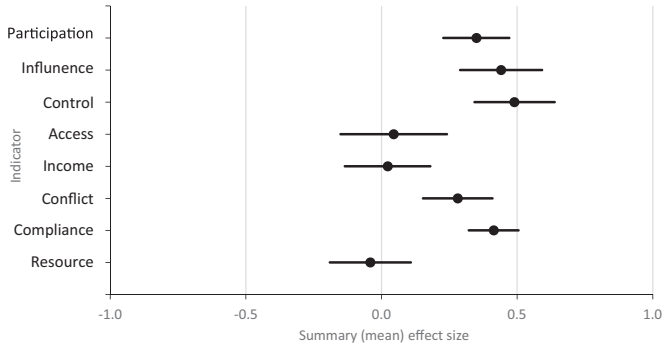

Fig. 2. Summary effect sizes (in Log) of eight indicators of CBFM projects and programs in the Philippines.

size of p th program or project in the group g, w_{pg} stands for the weight of the effect size of p th program or project in the group g.

The significance of both Q_i and Q_{btw} were tested against the χ^2 distribution with $k-1$, and $g-1$ degrees of freedom respectively. All meta-analyses were conducted using random-effects model in Comprehensive Meta-Analysis (CMA) version V3.3 [20].

3. Results

By extraction of eight common indicators in 13 projects and programs, the effect size of CBFM for each indicator was constructed and calculated in the form of modified response ratio (*RR*). Summary effect size for each indicator was calculated, also the inconsistency of the effect sizes was detected. This inconsistency [27] quantitatively indicated that there were true-effect differences (population variation) between projects or programs other than differences caused by sampling error [20,21]. Also, the results of categorical analyses and meta-regressions were reported by presenting how the true-effect difference impacts each effect size and the relation between each summary effect sizes and characteristics of the fishing households.

3.1. Effect sizes

Nearly all summary effect sizes of indicators in CBFM projects and programs selected in this study showed a positive change in the Philippines (Fig. 2). *Participation* ($\overline{RR}=1.42$, $CI=1.26-1.60$), *influence* ($\overline{RR}=1.55$, $CI=1.34-1.81$), *control* ($\overline{RR}=1.63$, $CI=1.41-1.89$), *compliance* ($\overline{RR}=1.51$, $CI=1.38-1.66$), *conflict* ($\overline{RR}=1.32$, $CI=1.17-1.51$), *access* ($\overline{RR}=1.05$, $CI=0.86-1.27$) and *income* ($\overline{RR}=1.02$, $CI=0.87-1.20$) were all perceived to increase through CBFM projects and programs. While the summary effect size of *resource* ($\overline{RR}=0.96$, $CI=0.83-1.11$) revealed a negative change for all included projects and programs.

3.2. Meta-regression

Although the magnitude of summary effects were estimated by a weighted average of same effect size in each project, eight effect sizes were discovered of being quite inconsistent across projects and programs. Having the results of heterogeneity test using Q statistic and I^2 Statistic (Table 4), almost all effect sizes (except *compliance*) were discovered to be inconsistent across projects and programs with statistical significance. It is noted that this true difference in effect sizes will not fade out when there is a boost in sample size. In this study, the I^2 statistic indicated that, on average, 71% of observed variances were true-effect difference for each effect size between projects and programs rather than the spurious sampling errors.

Table 4
Heterogeneity test (Q-statistic) of effect sizes in the meta-analysis.

Indicator	Q-value	P-value	*df*.(Q)	I-squared
Participation	53.78	0.000	30	68.39
Influence	87.01	0.000	30	80.46
Control	53.31	0.000	30	69.99
Compliance	26.91	0.059	30	36.82
Conflict	40.72	0.001	30	60.71
Access	98.46	0.000	30	83.75
Income	128.65	0.000	30	86.01
Resource	114.10	0.000	30	84.22

Table 5
Characteristics of fishing households.

Independent Variable	Definition
Household Size	The number of workforce in a household, including the ones who are working outside the village.
Residing Year	The number of years that respondent had resided in the village before the implementation of CBFM projects or programs.
Environmental Education	The number of years of formal schooling.
Duration	The number of years of implementation of CBFM program or project.

Such high level of heterogeneity originated from true differences deserved a further investigation on the relation between each summary effect size (dependent variable) and the characteristics of fishing household (independent variable in Table 5). Meta-regression was applied to assess this relationship using OLS estimation.

Let

$$\mathbf{Y_i}=\begin{bmatrix} Ln(RR_{i1}) \\ \vdots \\ Ln(RR_{ij}) \end{bmatrix}, \mathbf{X}=\begin{bmatrix} 1 & HS_1 & RY_1 & ED_1 & DU_1 \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ 1 & HS_j & RY_j & ED_j & DU_j \end{bmatrix}, \beta_i=\begin{bmatrix} \alpha_i \\ \beta_{i1} \\ \beta_{i2} \\ \beta_{i3} \\ \beta_{i4} \end{bmatrix}, \mathbf{u_i}=\begin{bmatrix} u_{i1} \\ \vdots \\ u_{ij} \end{bmatrix}$$

i is the number of effect size ($i=1,\ ...,8$); j is the number of site-study ($j=1,\ ...,31$). *HS*, *RY*, *ED*, and *DU* are the sample mean of the indicators of Household Size, Residing Year, Environmental Education, and Duration, respectively. $Ln(RR_{ij})$ is the effect size of *ith* indicator in site-study *j*.

$$\mathbf{Y_i}=\mathbf{X}^*\beta_i+\mathbf{u_i} \tag{11}$$

The results of meta-regression were shown in Table 6. With the inspection of the significance of both Q_{model} and $Q_{\text{resid.}}$ at 95% confidence level in the meta-regression, it is noted that other than the effect size of *access* and *resource*, all other six effect sizes were well supported by the selected characteristics of fishing household.

Almost all summary effect sizes had a positive coefficient with environmental education, household size and duration of program or project. More specific, for the relations that were statistically significant, the summary effect size of *participation* would increase 16%, 5%, and 3% by the marginal increase in environmental education, household size, and duration of CBFM program or project, respectively. The summary effect size of *influence* would increase 16%, 7%, and 2% with the marginal increase in environmental education, household size, and duration of CBFM program or project, respectively. The summary effect size of *control* would increase 6% and 4% with the marginal increase in environmental education and duration. The summary effect sizes of *compliance* would increase 2%, 3%, and 3% with the marginal increase in environmental education, household size, and duration, respectively. The summary effect sizes of *conflict* would increase 12% and 1% with the marginal increase in environmental education and duration. The summary effect sizes of *income* would increase 5%, 4% with the marginal increase in household size and duration. While, the relations between the summary effect sizes of *access* and *resource* and all

Table 6
Meta-regression analyses between characteristics of fishing households and performance indicators.

	Residing year	Education	Household size	Duration	Q_{model}-*Sig.*	$Q_{resid.}$-*Sig.*
Participation	−0.01 (0.02)	0.16 (0.08) **	0.05 (0.02) ***	0.03 (0.02) **	0.000	0.250
Influence	0.05 (0.02) **	0.16 (0.08) **	0.07 (0.02) **	0.02 (0.02)	0.000	0.091
Control	0.00 (0.02)	0.06 (0.03) ***	0.02 (0.02)	0.04 (0.02) **	0.011	0.362
Compliance	−0.00 (0.02)	0.20 (0.08) ***	0.03 (0.02) **	0.03 (0.02) **	0.000	0.537
Conflict	0.00 (0.02)	0.12 (0.05) **	0.04 (0.02)	0.01 (0.02) **	0.027	0.022
Access	−0.03 (0.02)	−0.14 (0.14)	0.03 (0.03)	0.03 (0.02)	0.606	0.000
Income	−0.01 (0.02)	−0.07 (0.08)	0.05 (0.02) **	0.04 (0.02) **	0.039	0.141
Resource	−0.01 (0.03)	0.03 (0.16)	0.06 (0.04)	0.03 (0.03)	0.557	0.000

Statistical significance is noted by two asterisks (**) at the 5% level, and three asterisk (***) at the 1% level.

four household characteristics (residing year, environmental education, household size, and duration) was not statistically significant. Also, the statistically significant of $Q_{resid.}$ for these two effect sizes indicated that there was significant amount of unexplained variations in the residual and these two effect sizes were not well supported by the given characteristics of fishing household. Although there were two explanatory variables (environmental education, duration) that has positive coefficients with statistically significance, the statistically significant $Q_{resid.}$ of the effect size of *conflict* revealed that some variations were not full explained by this linear model.

3.3. Categorical analysis (Subgroup meta-analysis)

The results of meta-regression presented a positive coefficient of duration associated with all summary effect sizes in which five were statistically significant. This general positive relation indicated a better performance of indicators (larger summary effect size) when a longer duration of CBFM was in place (especially to the ones with statistically significant). However, any project or program has its budget constraint even in the planning stage. Thus, how many years of intervention would have a statistically significant improvement on target indicators becomes fundamental for fishing households, donors of program or project, and the development department of local government. Categorical analysis was carried out to identify the "threshold year" of summary effect sizes that showed a statistically significant relation with duration of projects and programs in the meta-regression, including *participation*, *control*, *compliance*, and *income*. It worth noting that the median and the mean of duration of CBFM projects and programs included in this study was 9 and 9.73, respectively. The significance of Q_{btw} was tested against the chi-square distribution with degree of freedom of one for each effect size between groups which differed by duration of projects and programs.

For the effect sizes that have statistically significant relations with duration of CBFM from the meta-regression, the threshold year of improvement in summary effect size with statistically significant was considerably varied (Table 7). The summary effect size of *participation* and *control* were shown to be improved with statistically significance when the duration of CBFM was at least over (or equal) eight years. The summary effect size of *compliance* needed two more years to be improved with statistical significance. While the summary effect size of *income* needed a considerably longer implementation time (15 years) of CBFM project or program for achieving improvement with statistical significance. For the summary effect sizes that did not have statistically significant relations with duration of CBFM from the meta-regression, the threshold year of improvement in effect size with statistically significance were also revealed by categorical analysis (except for *conflict*). The summary effect size of *access* was shown to be improved with statistically significance when the duration of CBFM was at least over (or equal) six years. The summary effect size of *influence* needed four more years to be improved statistically significant. The summary effect size of *resource* needed an extra four years (14 years) of implementation of CBFM for achieving improvement with statistical significance.

4. Discussion

Overall, the summary effects of CBFM in the Philippines were considered as positive for all indicators included in this study. However, the magnitude and heterogeneity, the most influential factors, and the onset time of each summary effect size were revealed quite differently. All summary effect sizes are discussed below in the dimensions of equity and sustainability.

4.1. ***Equity dimension*** *(participation, influence, control, access, income)*

It is noted from the results that the summary effect sizes of *participation*, *influence*, *control*, *access* and *income* all have a mean response

Table 7
The statistical significance of the difference in subgroup means of effect size.

Groups (years of duration)	Q_{btw}−*Statistic*							
	Participation	Control	Compliance	Income	Conflict	Access	Influence	Resource
< 2 and ≥ 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
< 4 and ≥ 4	0.86	1.35	0.63	0.05	0.26	0.10	1.44	0.49
< 5 and ≥ 5	0.08	0.00	0.00	1.28	0.51	1.25	0.05	1.53
< 6 and ≥ 6	0.16	0.36	0.10	1.62	1.43	4.20**	0.12	3.15
< 7 and ≥ 7	0.00	0.24	0.56	0.45	2.68	0.05	0.04	0.64
< 8 and ≥ 8	5.13**	3.99**	3.28	0.00	0.00	0.01	1.07	0.05
< 9 and ≥ 9	3.37	1.54	0.94	0.05	0.76	0.20	1.03	0.00
< 10 and ≥ 10	1.83	6.58**	6.72**	0.04	0.04	0.13	7.83**	0.42
< 11 and ≥ 11	1.13	4.88**	3.20	0.23	1.48	0.12	3.80	1.45
< 12 and ≥ 12	0.47	3.78	3.58	0.29	0.86	1.27	2.76	0.99
< 14 and ≥ 14	0.43	6.44**	2.55	1.60	2.42	0.40	0.99	4.64**
< 15 and ≥ 15	2.39	0.64	0.16	6.52**	2.14	0.12	2.58	2.99
< 21 and ≥ 21	1.96	0.39	1.88	0.34	0.04	0.01	0.37	1.73

Statistical significance is noted by two asterisks (**) at the 5% level.

ratio over 1, which indicates that the fisheries under CBFM had better performance on these five indicators than the control group in the Philippines. Other than the effect sizes of *access* and *income*, the other three effect sizes were statistically significant. This coincides what Viswanathan and others [28] argued in that equity is one distinct advantage of CBFM. The results of this study verified this argument quantitatively and revealed sizeable magnitude (33% increase in weighted mean effect size) of equity improvement in fishing households involved in CBFM.

A high level of heterogeneity (I^2 was 77.72 on average) was also discovered for the equity effect sizes, which indicated the effect sizes of equity were not consistently perceived across sites in different projects and programs. This high degree of heterogeneity was also stated in several studies as the site-specific nature of CBFM [27,29,30]. The effect size of *access* ($I^2 = 83.75$), *resource* ($I^2 = 84.22$) and *income* ($I^2 = 86.01$) revealed considerable heterogeneity, which are the reflection of the poorly managed nature of the marine fisheries and the highly dynamic and site-specific characteristic of fisheries resources. More causes of heterogeneity were investigated in the meta-regression below.

From the results of the meta-regression, environmental education stood out as an influential factor [31–33] on the effect size of *participation*, *influence*, and *control* with 16%, 16%, and 6% contribution, respectively, when every one extra year of environmental education is added. The issues of community-based management are generally complex and there is a urgent need to promote environmental awareness in the community and to develop people's capacity to actively participate in the management program. The purpose of environmental education, capacity development is to empower people with knowledge and skills in order to begin to take greater control over resource, economic and social problems and needs, negotiate a fair agreement, and increase their awareness and understanding of fisheries resources and thrit managmenet. Through environmental education, community members are able to better understand the needs for and the approaches to CBFM, as well as their specific individual and collective roles in CBFM. In some scenarios during CBFM, the community may need to be convinced of the need to protect and sustainablly manage their own resources. This awareness rising process is fundamental to CBFM and should be inplaced as soon as possible in order to empower fisheres with knowledge and skill so that they can actively and effectively participate in the CBFM.

The household size contributed to the effect sizes of *participation* (5%), *influence* (7%), and *income* (5%) with its marginal gain. In small-scale fishing communities, fishing-crew members and other fisheries-related workers are often recruited by their important social ties in the community, rather than by their particular skills, experience, or labor price [34]. Thus, bigger household size tended to have more family relationships in the community. Therefore, the household members perceived to have a higher level of involvement and bargaining power in their community. The positive relationship between household size and income was not only because more workforce could generate more revenue, but also due to the prevailing remittance tradition in Asia, which is characterized by sending money back home from members who are working outside the village [35].

The duration of CBFM was another important factor explaining the heterogeneity in effect sizes across projects and programs. With 3%, 4%, and 4% contribution to the effect sizes of *participation*, *control*, and *income,* respectively, it was favorable to have a longer period of implementation of CBFM for equity improvement. Longer duration of projects or programs enables the better understanding of objectives, interventions and management measures. As the fundamental characteristics of CBFM indicates, fishers are the ones who exercise primary responsibility for stewardship and management, including taking part in decision-making on all aspects of management, such as access, harvest, and monitoring [8,29,36]. Thus, with a longer and stable management plan in place, fishers have more willingness to make their voice heard and get involved in managing resources on which they and their families depend the most.

However, with the budget constraint that every government or NGO or any other agency has to consider, a longer time period is not always favorable to them. Different objectives might require a different length of implementation. By employing categorical analysis to the selected projects and programs, a certain length of time (threshold-year) was identified for each effect size to reveal a difference with statistical significance. The threshold-years for the effect sizes of *participation*, *control*, *access*, and *income* were shown differently. The improvement on *participation*, *control* and *control* all required at least eight years of implementation of CBFM. The threshold-years for *access* and *income* were perceived differently. The effect size of *access* had the shortest threshold-year (6 years) out of all effect sizes. CBFM emphasizes self-initiated management where the fishers take responsibility for a number of functions, including distribution of the resource, entry and withdrawal. Thus, an improvement in access could be theoretically achieved fairly quickly after the establishment of CBFM if ideal compliance is presented [29]. Moreover, because the management complements local cultural values, the incentives to respect and support the rules are self-imposed, and are seen as individually and mutually beneficial [37]. To the contrary, the threshold year for the effect size of *income* was discovered as the longest in all effect sizes, with the statistically significant difference appeared in 15 years of CBFM. This considerably long time-span for the improvement on effect size of *income* has not only to do with the longer recovery time of resource which will be discussed in the sustainability dimension, but also indicating the difficulty for establishment of income-generation alternatives for this specific sector [7,38]. It is important to note that Pomeroy [39] suggest that fishers like their occupation and would not necessarily change to another one. Crawford [40] also indicated that willingness to change occupation was much lower among poorer, younger, less educated, and less successful fishers due to the risks of new activities. Thus, the development of supplemental rather than alternative occupations, encouraging a shift from full-time fishers to part-time fishers would be a more realistic goal.

4.2. ***Sustainability dimension*** *(conflict, compliance, resource)*

The summary effect sizes of *conflict* and *compliance* were perceived to be greater than one, while the *resource* was perceived to be less than one after implementation of CBFM in the Philippines for the selected projects and programs. Except for the effect size of *resource*, the other two effect sizes were statistically significant. A possible explanation for the *resource*, given the positive *conflict* and *compliance*, is that the fish populations have been recovering at a very slow pace from a bad starting point [18]. Given that more than 90% of the nearshore fishing grounds have been fished down to 5–30% of their original unexploited levels in the Philippines [18,41,42], this is reasonable explanation. In addition, illegal fishing and destructive fishing were not completely precluded from outsiders [43–45]. The potential competitiveness between community organized fishers and outsiders could lead to fluctuations on both effect size of *resource* and *conflict* [46], which were reflected by sizable inconsistency across sties in different projects and programs, with 84% and 64% of variation originating from true differences.

Through the meta-regression, environmental education was again discovered to be a very influential factor on *compliance* and *conflict*. The effect size of *compliance* and *conflict* increased 20% and 12%, respectively, when one more year of environmental education is gained. The meta-regression reported that environmental education, household size, and duration contributed 20%, 3%, and 3%, respectively, to the effect size of *compliance*, which further emphasized the crucial role of fishers' environmental education, not only to improve equity among fishers but also to facilitate the sustainability of CBFM [40]. With the statistically significant positive relationship between effect size of *compliance* and the *duration*, a categorical analysis was conducted and

revealed that the threshold years of the effect size of *compliance* was ten years. The threshold-year for effect size of *compliance* is comparable to the effect sizes of *participation* (8 years) and *control* (8 years) for similar reasons as mentioned above. Also, it is noted that the improvement with statistical significance in *compliance* happened later than the threshold-years of *participation* and *control*. Higher *participation* and *influence* indicated more acceptance and approval of CBFM by the fishing households [28]. In the article by Pomeroy and Carlos [9], they found that it takes 5 years on average to organize and empower fishers and developing the social capital of fishers to manage a fishery takes times. Also, one of the benefits of the self-managing approach is higher efficiency and effectiveness in enforcement and monitoring process than bureaucracies can do [37]. Together with these two factors, the high level of conformity of behaviors with prescribed rules and regulations was expected.

For the effect size of the *resource*, although the regression model did not explain well the variation of *resource* based on selected covariates, duration was still suspected of having a relationship with the effect size of the *resource*. Thus, a categorical analysis was employed to seek if any relationship existed. The difference between the duration of CBFM and weighted effect size of *resource* was statistically significant at 14 years of CBFM. This considerably long period of intervention is in coordination with the effect size of *income* which also needs a comparable 15 years of CBFM for a statistically significant improvement as was mentioned in the equity dimension discussion above. It is noted that some projects and programs reported a fish abundance increase in the relatively shorter period than the results of the study [47,48]. The discrepancy was due to two major differences: (1) application of control group difference, and (2) the difference in measurement. As mentioned in the methodology, this study incorporated a quasi-experimental with difference in difference (DID) method, which incorporated control groups difference to counteract factors that might have impacts upon certain indicators by factors that are beyond the influence of interventions. For the second difference, some studies use biomass for measurement which was relatively quicker and easier to recover compared to the “higher value” fish.

5. Conclusions

Pomeroy [39] argued that fishing communities, under certain conditions, can regulate access and enforce rules through community institutions and social practices to use fisheries resources sustainably. Recent studies on coastal fisheries management in the Philippines also argue that the approach of community-based fisheries is capable of removing the competition out of the fisheries and focusing the community as a whole on practicing fisheries in a sustainable manner [49,50].

The overall outcomes of the meta-analyses in this study indicates a positive impact of CBFM on the equity of both involvement in management and benefit sharing, as well as sustainable management of fisheries resources in the Philippines, through the investigation of the effect sizes of eight indicators. The positive summary effect sizes of *participation*, *influence*, *control*, *access*, and *income* conjunctly portrayed an improved equity in the fishing community by implementing CBFM. The positive summary effect sizes of *compliance* and *conflict* indicated an affirmative community and, therefore, sustainable fisheries management. While the negative summary effect size of *resource* revealed the difficulties in recovering fish abundance in a relatively short period of time. For further improvement of CBFM, investment in workshop or other forms of knowledge spreading about sustainable fisheries will be the most effective manner for most of the effect sizes [51,52].

As for the duration of implementation, different effect sizes were revealed to have different length of time for CBFM to show improvements. In the equity dimension, the effect size of *access* showed statistically significant improvement at six years of implementation of CBFM, which was the shortest duration of all eight effect sizes. Ten years of implementation was discovered as the duration with perceived equity improvement because it provided a statistically significant increase in all effect sizes in this dimension except for *income*. In the sustainability dimension, ten years was also found to be the duration with statistically significant improvement, except for *resource*. For both *resource* and *income*, 14 and 15 years of CBFM showed statistically significant improvement, respectively. It should keep in mind that by incorporating control group in constructing effect sizes in this paper, the exogenous factors (natural trends) were isolated from the impacts of intervention, which means all factors that would have impact on the targeting indicators but are not associate with projects interventions were controlled. The considerably longer time span than other effect sizes should not be surprising due to the status of heavily overexploited fisheries resource and high level of dependence on fisheries by the fishing communities in the Philippines. In contrast to the 5-year-plan proposed by most donors for fisheries projects and programs implementation, this study indicated that supports will still be needed to ensure the sustainability of fisheries management after commonly made 5-year-plan, and discovered that a considerable longer implementation period is needed for performance improvement. Even for the management aspects such as *participation*, *influence*, *compliance*, *conflict*, *access*, and *control*, which are usually expected to show a quicker improvement after implementation of CBFM, five-years is not enough time to be able to achieve statistically significant improvement; let alone the management that will sustain after the end of the project or program. The *resource* and *income* improvements should expect to require even longer implementation of CBFM or multiple phases of CBFM to be able to achieve statistically significant improvement.

From the perspective of resource users, CBFM was prompted by their dependence on fishery resources for livelihood, recognition of resource management issues by local fishers, and participatory management using collective knowledge and decision-making by resource stakeholders. The intimate knowledge and local specific experiences make fishers participation in resource management unique and efficient. From the perspective of fisheries resources, the tangible benefits in the form of higher fish catch and therefore higher income and more sustainable livelihood further encourage better rule compliance and further elimination of illegal and destructive fishing practices over time.

This study was not an exhaustive performance evaluation due to the limited indicators and project availability, but it does shed some light on the impacts of CBFM on equity of management involvement and benefit sharing, as well as sustainable management of fisheries resource. This study also provided a first attempt to evaluate and analyze the effect sizes of CBFM by utilizing meta-analysis (random-effects model) and meta-regression, which is relevant to improving the quality of livelihoods among poor rural people, as well as to facilitate poverty alleviation. Rather than a qualitative synthesis, which suffers from the subjectivity of drawing a conclusion from various studies, meta-analysis is capable of statistically synthesizing the data to discover the direction and magnitude of the summary effect of CBFM across projects and programs in a transparent, objective, and replicable manner [20]. Moreover, the results can be used as relevant information for institutions and donors who want to apply community-based fisheries management for rural development and fisheries resource management.

Acknowledgements

The authors want to express appreciation to Dr. Paul Thompson at WorldFish Center, Dhaka, Bangladesh, Dr. Gazi Nurul Islam, associate professor at the Universiti Tun Abdul Razak, for kindly providing relevant literature and assistance for data extraction. It would be impossible to complete this research without the help from any of them. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

References

[1] R.F. Agbayani, T.U.B.E.E.C. Flores (Ed.), Community fishery resources management in Malalison Island, Philippines, Towards sustainable aquaculture in Southeast Asia and Japan, Iloilo City, Philippines, 1995, pp. 209–219.

[2] C.L. Delgado, N. Wada, M.W. Rosegrant, S. Meijer, M. Ahmed, Fish to 2020: supply and demand in changing global markets, International Food Policy Research Institute, Washington, D.C., 2003 (WorldFish Center, Penang, Malaysia).

[3] R.S. Pomeroy, J. Parks, K.L. Mrakovcich, C. LaMonica, Drivers and impacts of fisheries scarcity, competition, and conflict on maritime security, Mar. Policy 67 (2016) 94–104, http://dx.doi.org/10.1016/j.marpol.2016.01.005.

[4] R.S. Pomeroy, K.K. Viswanathan, Experiences with fisheries co-management in Southeast Asia and Bangladesh, in: D.C. Wilson, J.R. Nielsen, P. Degnbol (Eds.), The fisheries co-management experience: Accomplishments, challenges, and prospects. Springer, Netherlands, Dordrecht, 2003, pp. 99–117.

[5] World Bank, Fish to2030: prospects for Fisheries and Aquaculture, World Bank, Washington, D.C., 2013.

[6] E.M. Ferrer, L.P. Cruz, M.A. Domingo, Seeds of hope: a collection of case studies on community-based costal resources management in the Philippines, University of the Philippines, Diliman, Quezon City, Philippines, 1996.

[7] F. Berkes, R. Mahon, P. McConney, R. Pollnac, R. Pomeroy, Managing small-scale fisheries: alternative directions and methods, International Development Research Centre, Ottawa, ON, Canada, 2001.

[8] P.M. Thompson, Theoretical basis for community-based fisheries management in Bangladesh, Sustainable inland fisheries management in Bangladesh, International Center for Living Aquatic Resources Management, Makati City, Philippines, 1999.

[9] R.S. Pomeroy, M.B. Carlos, Community-based coastal resource management in the Philippines: a review and evaluation of programs and projects, 1984–1994, Mar. Policy 21 (1997) 445–464, http://dx.doi.org/10.1016/j.marpol.2009.03.003.

[10] E. Amar, R. Cheong, V. Tambasen-Cheong, L. Clarissa, L. Garcia, B. Ma, Community fishery resource management (CBFM) (Philippines): small-scale fisheries and yield of coral reefs in Malalison island, west-central Philippines, 2009.

[11] B. Katon, R.S. Pomeroy, Fisheries management of San Salvador Island, Philippines: a shared responsibility, Soc. Natur. Resour. 12 (1999) 775–795, http://dx.doi.org/10.1080/089419299279317.

[12] S. Hanna, User participation and fishery management performance within the Pacific fishery management council, Ocean Coast. Manag. 28 (1995) 23–44, http://dx.doi.org/10.1016/0964-5691(95)00046-1.

[13] M.L. Smith, G.V. Glass, Meta-analysis of psychotherapy outcome studies, Am. Psychol. 32 (1977) 752–760, http://dx.doi.org/10.1037/0003-066x.32.9.752.

[14] A. Abadie, Semiparametric difference-in-differences estimators, Rev. Econ. Stud. 72 (2005) 1–19, http://dx.doi.org/10.1111/0034-6527.00321.

[15] M. Lechner, The estimation of causal effect by difference-in-difference methods, Econometrics 4 (2010) 165–224, http://dx.doi.org/10.1561/0800000014.

[16] D.B. Baticados, R.F. Agbayani, Co-management in marine fisheries in Malalison Island, central Philippines, Int. J. Sust. Dev. World 17 (2000) 343–355, http://dx.doi.org/10.1080/13504500009470053.

[17] R.J. Maliao, Protecting the commons and sustainable development: evaluating the impacts of marine protected area in sagay, negros occidental, western Philippines, Asian Institue of Technology, Pathumthani, Thailand, 2002.

[18] E.L. Webb, R.J. Maliao, S.V. Siar, Using local user perceptions to evaluate outcomes of protected area management in the sagay marine reserve, Philippines, Environ. Conserv. 31 (2004) 138–148, http://dx.doi.org/10.1017/S0376892904001377.

[19] (a) L.V. Hedges, I. Olkin, Statistical Methods for Meta-analysis, Academic Press, Orlando, 1985;
(b) J.P.T. Higgins, S.G. Thompson, Quantifying heterogeneities in the meta-analysis, Stat. Med. 21 (2002) 1539–1558, http://dx.doi.org/10.1002/sim.1186.

[20] M. Borenstein, L.V. Hedges, J.P.T. Higgins, H. Rothstein, Introduction to Meta-analysis, John Wiley and Sons, Chichester, U.K., 2009.

[21] N.A. Card, Applied Meta-analysis for Social Science Research, Guilford Press, New York, 2012.

[22] K.J. Kroeker, R.L. Kordas, R.N. Crim, G.G. Singh, Meta-analysis reveals negative yet variable effects of ocean acidificatio on marine organisms, Ecol. Lett. 13 (2010) 1419–1434, http://dx.doi.org/10.1111/j.1461-0248.2010.01518.x.

[23] L.V. Hedges, J. Gurevitch, P.S. Curtis, The meta-analysis of response ratios in experimental ecology, Ecology 80 (1999) 1150–1156, http://dx.doi.org/10.2307/177062.

[24] M.J. Lajeunesse, On the meta-analysis of response ratio for studies with correlated and multi-group designs, Ecology 92 (2011) 2049–2055, http://dx.doi.org/10.1890/11-0423.1.

[25] R. DerSimonian, N. Laird, Meta-analysis in clinical trials, Control. Clin. Trials 7 (1986) 177–188, http://dx.doi.org/10.1016/0197-2456(86)90046-2.

[26] M.W. Lipsey, D.B. Wilson, Practical Meta-analysis, SAGE Publications, Thousand Oaks, California, U.S, 2001.

[27] J.P.T. Higgins, S.G. Thompson, J.J. Deeks, D.G. Altman, Measuring inconsistency in meta-analyses, Brit. Med. J. 327 (2003) 557–560, http://dx.doi.org/10.1136/bmj.327.7414.557.

[28] K.K. Viswanathan, J.R. Nielsen, P. Degnbol, M. Ahmed, M. Hara, R.A. Nik Mustapha, Fisheries Co-management Policy Brief: Findings from a Worldwide Study, WorldFish Center, Penang, Malaysia, 2003.

[29] L. Weber Michael, Iudicello Suzanne, Obstacles and opportunities for community-based fisheries management in the United States, Portland, ME, 2005.

[30] K. Lobe, D. Berkes, The padu system of community-based resource management: change and local institutional innovation in South India, Mar. Policy 28 (2004) 271–281, http://dx.doi.org/10.1016/S0308-597x(03)00087-3.

[31] C.L. Dohrn, A new commons: Considering Community-based co-management for sustainable fisheries, Pomona College, Claremont, 2013.

[32] D.J. Nickerson-Tietze, Community-based management of sustainable fisheries resources in phang-nga bay, Thailand, Coast. Manag. 28 (2010) 65–74, http://dx.doi.org/10.1080/089207500263657.

[33] R.S. Pomeroy, R. Rivera-Guieb, Fishery Co-management: A Practical Handbook, CABI Publishing, Cambridge, 2005.

[34] J.R. McGoodwin, Understanding the Cultures of Fishing Communities: A Key to Fisheries Management and Food Security, Food and Agriculture Organization of the United Nations, Rome, 2001.

[35] U. Tietze, S.V. Siar, G. Marmulla, Rv Anrooy, Credit and Microfinance Needs in Inland Capture Fisheries Development and Conservation in Asia, Food and Agriculture Organization of the United Nations, Rome, 2007.

[36] T. Yamamoto, The Fundamental Difference in Fisheries Management between Japan and the Western Countries, Japan International Fishery Research Society (JIFRS), 1996.

[37] M.M. Dey, U. Kanagaratnam, Community-based Management of Small-scale Fisheries in Asia: Beidging the Gap Between Fish Supply and Demand, The WorldFish Center, Dhaka, 2007.

[38] FAO, Increasing the Contribution of Small-scale Fisheries to Poverty Alleviation and Food Security, Food and Agriculture Organization of the United Nations, Rome, Italy, 2005.

[39] R.S. Pomeroy, Community-based and co-management institutions for sustainable coastal fisheries management in Southeast Asia, Ocean Coast. Manag. 27 (1995) 142–162, http://dx.doi.org/10.1016/0964-5691(95)00042-9.

[40] B. Crawford, Seaweed Farming: An Alternative Livelihood for Small-scale Fishers? Coastal Resource Center, University of Rhode Island, 2002.

[41] I.C. Stobutzki, G.T. Silvestre, A.A. Talib, A. Krongprom, M. Supongpan, P. Khemakorn, Decline of demersal coastal fisheries resources in three developing Asian countries, Fish. Res. 78 (2006) 130–142, http://dx.doi.org/10.1016/j.fishres.2006.02.004.

[42] M. Tupper, F. Asif, L.R. Garces, M.D. Pido, Evaluating the management effectiveness of marine protected areas at seven selected sites in the Philippines, Mar. Policy 56 (2015) 33–42, http://dx.doi.org/10.1016/j.marpol.2015.02.008.

[43] IFAD, ANGOC, IIRR. Enhancing ownership and sustainability: a resource book on participation. IFAD, ANGOC, IIRR, 2001.

[44] L.V. Van Mulekom, E.C. Tria, Community-based coastal resource management in Orion (Bataan, Philippines): building community property rights in a fishing community, Naga 20 (1997) 51–55 (ICLARM).

[45] FAO, SPC. Report of the FAO/SPC Regional Workshop on Improving Information on Status and Trends of Fisheries in the Pacific Region, Apia, Samoa, 2010 FAO Fisheries and Aquaculture Report, 2010.

[46] R.S. Pomeroy, J. Parks, R. Pollnac, T. Campson, E. Genio, C. Marlessy, E. Holle, M. Pido, A. Nissapa, S. Boromthanarat, N. Thu Hue, Fish Wars: conflict and collaboration in fisheries management in Southeast Asia, Mar. Policy 31 (2007) 645–656, http://dx.doi.org/10.1016/j.marpol.2007.03.012.

[47] SUMACORE, Sustainable management of coastal resources projects the Kingdom of Spain, 2010.

[48] USAID, The Fisheries Improved for the Sustainable Harvest (Fish) Project, United States Agency for International Development, 2010.

[49] J. Graham, A. Charles, A. Bull, Community Fisheries Management Hand Book, Saint Mary's University, Gorsebrook Research Institute, 2006.

[50] The WorldFish Center, Gender and Equity: Reducing Poverty and Hunger by Improving Fisheries and Aquaculture, The WorldFish Center, 2011.

[51] K.H.M.A. Deepananda, U.S. Amarasinghe, U.K. Jayasinghe-Mudalige, Indigenous knowledge in the beach seine fisheries in Sri Lanka: an indispensable factor in community-based fisheries management, Mar. Policy 57 (2015) 69–77, http://dx.doi.org/10.1016/j.marpol.2015.03.028.

[52] P. Sultana, P.M. Thompson, Community-based fisheries management and fisher livelihoods: Bangladesh case studies, Hum. Ecol. 35 (2007) 527–546, http://dx.doi.org/10.1007/s10745-006-9092-3.