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Original Article

Impact of community-based natural resource management on household consumption: a case study of Tonle Sap Lake, Cambodia

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Abstract

Community-based natural resource management (CBNRM) is implemented in Tonle Sap Lake (TSL), Cambodia after abolishment of commercial fishing lots in 2001 and 2012. One objective of CBNRM implementation is to reduce poverty of the local communities in TSL. This study aimed to examine the impact of CBNRM on household consumption of fishermen in TSL through Propensity Score Matching method by comparing 248 non-CBNRM households and 223 CBNRM households This study reveals that CBNRM had a negative impact on adult equivalent consumption in the community including the fishermen who fished only inside the community boundary and those who fished both inside and outside the community boundary. However, this study also shows a positive impact of CBNRM on adult equivalent consumption of the households who fished only inside the community boundary. The local community needs more rights to exclude the migrant fishermen and rights to enforce the laws. This study also highlights that alternate income sources should also be created that could be created by expanding the market of the existing ecotourism-job, *i.e.* hyacinth-made handicraft making.

Keywords: CBNRM; Tonle Sap Lake; household consumption; Cambodia.

1 | INTRODUCTION

Tonle Sap Lake (TSL) is the largest freshwater fishing area in Southeast Asia connecting to the Mekong River. It covers six provinces in Cambodia. TSL provides fish that constitutes 70% of the protein intake to the Cambodians. Moreover, it is the main source of livelihood of about one million people living in and around TSL (Keskinen 2006). To generate the state revenue, large parts of TSL were under privatization for over 100 years. There were 139 commercial fishing lots operated by businessmen in TSL as of 2013 (Jones and Sok 2015). Tax evasion by the commercial fishery lots owners, ineffective upward accountability by the government officials working for fishery management in TSL and violent conflicts between commercial fishing lot owners and local fishermen led to the gradual abolition of commercial fishing lots through two fishery policy reforms in 2001 and 2012. The first fishery policy reform in 2001 converted approximately 56% of the commercial fishing lots to public fishing grounds and conservation areas. The second fishery policy reform in 2012 abolished the remaining commercial fishing lots and converted them to public fishing grounds and conservation areas (Jones and Sok 2015). The creation of public fishing grounds resulted in an increased illegal fishing activity in the lake which is a common and major reason of declining aquatic biodiversity (Galib 2015; Joadder *et al.* 2015; Galib *et al.* 2010, 2016). In 2006, as a part of the fishery policy reforms the Royal Government of Cambodia implemented community-

based natural resource management (CBNRM) by involving the local communities to manage fishery resources in TSL. CBNRM aims to reduce illegal fishing activities and poverty in TSL (Mak 2011). There were 175 CBNRM-implemented communities in 2006 in TSL which increased to 228 by 2013 (Mak 2011; Jones and Sok 2015,).

Whether CBNRM implementation can achieve its objective in poverty reduction is still doubtful because of two reasons. Firstly, from the theory point of view, CBNRM is not applicable in TSL. The theory from which CBNRM was developed is partly based on five successful cases presented by Ostrom (1990). Those resources were stationary resources and in small-scale. Moreover, the local communities had some forms of property rights whereby they could exclude outsiders or non-members from exploiting the resources in their community (Araral 2014). However, the fishery resources in TSL were mobile resources and in large scale spanning national and regional boundaries. In addition, the local communities had no right to exclude the outsiders or non-members from exploiting the resources in their communities. Therefore, CBNRM may not be applicable for fishery resource management in TSL.

Secondly, it is the failure of the government in two aspects that may cause the failure of CBNRM implementation in TSL. These are: the failure to create alternative sources of income for the local communities and the failure to empower the local communities to punish illegal fishermen, making them have limited property rights to manage the fishery resources effectively (Thol and Sato 2014; Jones and Sok 2015). CBNRM-implemented communities have only the rights to manage the resources by enacting their own bylaws and internal regulations, but they have no rights to enforce those bylaws and regulations. The power is still largely in the hand of the government institutions (Thol and Sato 2014; Jones and Sok 2015). It is very important that the local communities are granted the property rights because property rights are considered the most important factor for successful natural resource management (Agrawal and Ostrom 2001).

Most studies in TSL focused on the impact of the fishery policy reforms on household consumption rather than the impact of CBNRM on household consumption (e.g. Thol and Sato 2014; Jones and Sok 2015). It indicates that those studies equated fishery policy reforms to CBNRM despite the fact that not all local communities in TSL have implemented CBNRM. There are also a few studies differentiating the impact of the fishery policy reforms from that of CBNRM. However, those studies used only the perception-based method to evaluate the impact of CBNRM on household consumption by asking if their consumption was better or worse off after CBNRM implementation (e.g., Nuon and Gallardo 2011). So far there has not been any study that uses quantitative methods to examine the impact of CBNRM on the household consumption of the fishermen. Thus, this study aimed to examine the impact of CBNRM on household consumption by comparing a CBNRM-implemented community to a non-CBNRM implemented community.

2 | METHODOLOGY

2.1 | Study framework

Two study areas (Chivieng and Preak Sromoach) were selected to fulfill the research objective (Figure 1). This study was conducted for a period of three months from March to May 2015.

FIGURE 1 Map of the study areas (Source: Google Maps)

Chivieng community was selected as the treatment because CBNRM is being implemented in TSL. Preak Sromoach community was considered a control (as baseline data) in this study. Chivieng community is located in Kors Chivieng commune, Eak Phnom district, Battambang province which consists of three villages called Preak Toal, Kompong Prohok, and Ornlong Taour. The total number of households in these villages was 1,448 (as of 2014). The major occupation in Chivieng community was fishing, which comprised around 90% of the total population, and the rest of the population were engaged in fish trading, aquaculture, and ecotourism jobs (e.g. cooking and providing accommodation to tourists). Preak Sromoach community is located in Kompong Khleang commune, Sourt Nikom district of Siem Reap province and also composed of three villages *viz*. Preak Sromoach, Spean Veng, and Taour Sor. As of 2014, the total number of households was 938 and like in Chivieng community, around 90% of the households in Preak Sromoach community were fishermen, and some of them engaged in fish trading and aquaculture.

Chivieng community was selected in this study for three reasons. Firstly, when CBNRM started to be implemented in TSL, it was one of the first communities to implement it. Secondly, since the objectives of CBNRM implementa-

tion in TSL are to reduce poverty and conserve fishery resources, alternative income sources in TSL have to be created. The local communities can earn more from those sources and reduce fishing efforts, leading to poverty reduction and fishery resource conservation. Chivieng community was one of a few CBNRM-implemented communities that established ecotourism as an alternative income source for improvement in household consumption in the community. And lastly, according to key informants comparing with other CBNRM-implemented communities, consumption status in many households in Chivieng community was dramatically affected after the first fishery policy reform in 2001. Prior to the reform in 2001, many people in this community worked as sub-leasers (*i.e.* the fishermen bought a certain fishing ground from the commercial fishing lot owners to fish), sub-sub leasers (other than buying from the commercial fishing lot owners, the fishermen bought a certain fishing ground from the sub-leasers to fish), or fish laborers with the commercial fishing lots. Therefore, after the reform, those households lost their jobs, affecting their income and consumption.

There were many non-CBNRM implemented communities in TSL having similar characteristics to Chivieng community. However, there were only a few communities that were not affected by the fishery policy reforms, and Preak Sromoach community was one of them. According to the key informants in Preak Sromoach community, abolishment of the commercial fishing lots after the first and second fishery policy reforms in 2001 and 2012 did not significantly affect consumption of the households in this community because only a few households worked with the commercial fishing lots.

There are two groups of fishermen in TSL: (1) those who only fish inside their community boundary that was administratively established by local government officials and (2) those who fish both inside and outside the community boundary with the use of productive fishing assets like motorized boats and ice cooler boxes for preserving the caught fish. According to Mak (2011), the first group was normally poor because they did not have money to invest in the productive fishing assets as the second group did. Since they were poor, the first group's consumption was likely to be more affected by any change due to project or policy implementation like CBNRM than the second group. Therefore, to examine closely the impact of CBNRM, this study first focused on the impact of CBNRM on household consumption on the community consisting of both the households who fished only inside the community boundary and those who fished both inside and outside the community boundary. Second, this study focused on the impact of CBNRM on household consumption of the first group of the households who fished only inside the community boundary.

2.2 Primary data collection

2.2.1 | Focus group discussions (FGDs)

Two FGDs were conducted with ten community members from each community who were identified based on types of fishing equipment used in case of Preak Sromoach community and types of fishing equipment and frequency of participation in CBNRM activities in case of Chivieng community. The main purpose of FGDs was firstly to know their general opinion on the impact of fishery policy reforms on their consumption. Secondly, for Chivieng community, the purpose of FGDs was to know the impact of CBNRM on household consumption.

2.2.2 | Key informant interviews

Five key informants were chosen in each study area. They were village and commune chiefs, local government officials, and non-governmental organizations. The interviews aimed to find out the general situations in the communities as well as their roles in improving household consumption in the communities.

2.2.3 | Household interviews

A convenient sampling method was used to select household respondents due to the difficulty in meeting with the households in the community owing to their fishing activity patterns which involved going in the night for some and during the day for others. A total of 471 households were selected and face-to-face interview was conducted by the author. A semi-structured questionnaire was used to collect the data on socioeconomic characteristics and household consumption of the respondents.

2.3 | Data analysis

2.3.1 | Model for adult equivalent consumption

The model for adult equivalent consumption was adopted from the previous study made by Haughton and Khandker (2009) as well as based on the study context. Household characteristics used in this study included number of household members living in the house over the last 12 months, age, education and gender of the household head, and the interaction terms between education and gender of the household head.

Adult equivalent consumption was calculated by dividing the total consumption of a household with adult equivalent (AE). To calculate the total consumption of a household, both food and non-food consumption like clothes, communication, and utility were taken into account. Household consumption from non-timber forest products (NTFPs; wild vegetables and fuel woods from flooded forest) was also included in the household consumption.

NTFPs were considered in the household consumption because they were important sources of food and NTFPs were collected from flooded forests considered a part of fishery resources in TSL. Therefore, any change in fishery resource management may affect the flooded forests and household consumption of NTFPs. Household consumption of NTFPs was calculated at three steps. NTFPs were divided into two categories- NTFPs that could be sold in the market and the NTFPs that had the potential to sell in the market. Later, the household consumption of NTFPs was calculated for each category. Household consumption of NTFPs in the first category was calculated by multiplying their quantity (units consumed in households) with the retail price in the market. Household consumption of NTFPs in the second category was calculated by multiplying their quantity with the next best alternative or substituted NTFPs' price. Finally, the total household consumption of NTFPs was calculated by summing household consumption in the first category with that in the second category.

To calculate AE, the formula from the Organization for Economic Co-operation and Development (Haughton and Khandker 2009) was used. The OECD scale for AE is written as:

$$AE = 1 + 0.7(N_{adults} - 1) + 0.5N_{children}$$

where N_{adults} refers to the number of adults in a household, and $N_{children}$ refers to the number of children in a household.

2.3.2 | Propensity score matching (PSM)

Due to lack of baseline data of consumption, in Chivieng community, it was inopportune to compare the household consumption before and after CBNRM implementation. This study used PSM to construct the counterfactual outcomes for those living in the CBNRM-implemented community, Chivieng community, mimicking what the household consumption in Chivieng community would have been if they did not live there but in non-CBNRM implemented community, Preak Sromoach community.

The impact was calculated by using this formula $y_i = \alpha + \beta x_i + \lambda p_i + \varepsilon_i$ (Maddala 1983). y is the variable of interest adult equivalent consumption, x is the vector of exogenous explanatory variables (household characteristics), and p is the indicator for treatment ($p = 1$ if the household is living in Chivieng community, and $p = 0$ if the household is living in Preak Sromoach community), $\propto, \beta, \gamma$ are the unknown parameters and ε is the error terms, capturing unobservable factors as well as potential measurement error affecting y.

To ensure that results from PSM are valid, three assumptions need to be checked (Khan *et al.* 2012). The first assumption is that the Conditional Independence (CIA) must hold true, meaning that the outcome from project is independent of participation in the project conditional on a set of the observational variables X. If CIA does not hold true, PSM should not be used. There are two inferences from CIA assumption (Smith and Todd 2005). The first inference is by controlling all the observational variables X, the observed outcome for the control group is the same as the counterfactual outcome for the treatment group. Another inference is that the researcher has taken into account all the variables influencing potential and assignment outcomes simultaneously, and selection of the variables are based on the observable characteristics (Khan *et al.* 2012). To make sure that CIA is not violated, robustness of the results of the study was checked by using the Rosenbaum bounds sensitivity analysis (Rosenbaum 2002). The sensitivity analysis' value is denoted by *Γ.* Its accepted value in most of the literature using PSM is range from 1.1 and 2 (e.g. Clement 2011; Bertoli and Marchetta 2014). The sensitivity analysis was tested by using "rbounds" command in Stata. Its results were interpreted in the following section.

The second assumption is balancing properties. This assumption implies that two households with the same probability to participate in CBNRM have an equal proportion to be selected to place in control and treatment groups. Tests of balancing properties are to see whether at each propensity score's value, X has the same distribution for both the control and treatment groups (Lee 2011). To estimate the propensity scores (pscores), a binary choice model is used. Either probit regression model or binary logistic regression model can be used to estimate pscores as long as the dependent variable of the model has two values 0 and 1 (Rosenbaum and Rubin 1983). There is no difference between using the two models to estimate pscores. In this study, the binary logistic regression model was used. Stata version 12.1 was used to run the model (Table 1).

TABLE 1 Binary logistic regression estimation results

Variables	All households	Households fishing only inside community boundary
Household size	-0.66*** (0.17)	-0.038 (0.07)
Age	0.27* (0.14)	-0.16 (0.22)
Education	-0.54* (0.2)	0.48* (0.23)
Gender	-0.16 (0.44)	0.52 (0.48)
Education*Gender	0.93* (0.54)	-0.48 (0.58)
Constant	1.03 (0.37)	0.39 (0.4)
Pseudo R^2	0.17	0.19
Observations	471	348

*Asterisks represent level of statistical significance: * P = 0.1, ** P = 0.05, *** P = 0.001. Figures in parentheses are standard errors.*

When pscores are estimated, the data are split into equally spaced "pscores" intervals, which implies that within each of these intervals, the mean "pscores" of each conditioning variable is equal for the treatment and control groups, which is known as balancing properties. Pscores were divided into blocks among the households in the treatment group (Chivieng community) and those in the control group (Preak Sromoach) (Rosenbaum and Rubin 1983). Pscores for the blocks were not different, satisfying balancing properties.

The third assumption is the common support or overlap condition. This assumption implies that households with the same X value have a positive probability of being in the control and treatment groups (Heckman *et al.* 1999). The assumption can be tested by examining a graph of pscores across the treatment and control groups (Figures 2 and 3).

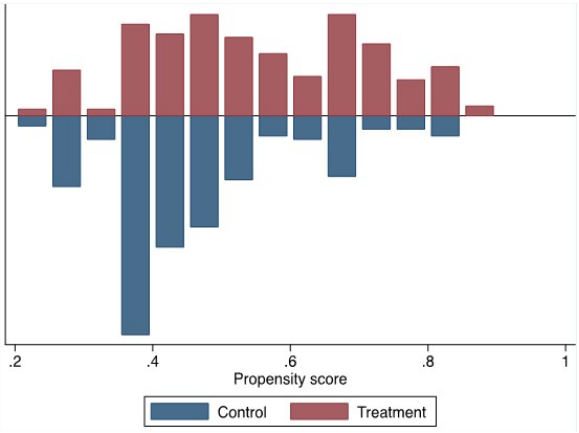

FIGURE 2 Propensity score for the households fishing only inside the community boundary and those fishing both inside and outside the community boundary

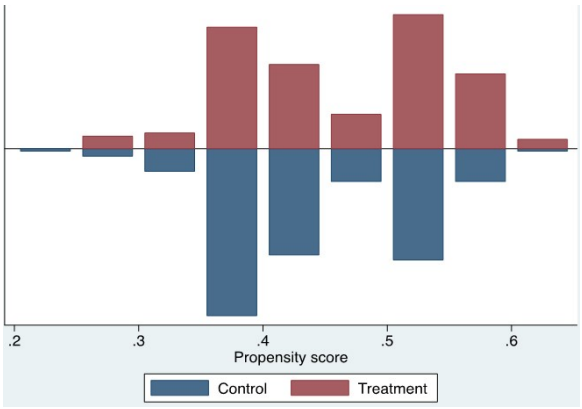

FIGURE 3 Propensity score for the households fishing only inside the community boundary

The Nearest Neighbor (NN) was used with and without replacement, Kernel and Radius matching methods, which are among the most popular methods. An advantage of utilization of different methods is it enables us to test the robustness of impact estimates (Becker and Ichino 2002). After running the model based on the aforementioned methods, balancing of covariates between the treatment and control groups was also checked to make sure that the treatment and control groups are well balanced (Tables 2 and 3).

3 | RESULTS AND DISCUSSION

3.1 Adult equivalent consumption

The household adult equivalent consumption in Preak Sromoach community was higher than that of Chivieng community, i.e. the treatment group (Table 4). There was not much difference between the average age, education, and household size of the household respondents between the two communities.

TABLE 2 Balancing of Covariate across the treatment and control groups for the households fishing only inside the community boundary and those fishing both inside and outside the community boundary

Methods	*Total samples*	*No. of treatment observations*	*No. of control observations*	*Mean Std. diff. in covariates (%)*	*Median Std. diff. in covariates (%)*
Original samples	471	232	239	36.2	35.3
Kernel matching	471	232	239	5.5	5.3
Nearest neighbor matching*	471	232	239	4	14.4
Nearest neighbor matching**	266	131	135	9.1	10
Radius matching	266	131	135	2.6	2.3

**without replacement, ** with replacement*

Adult equivalent consumption was much higher among the household respondents in Chivieng community than that in Preak Sromoach community (Table 5). There was a slight difference between the average age, education, and household size.

3.2 | Empirical results

3.2.1 | Impact of CBNRM on adult equivalent consumption of households fishing only inside the community boundary and those fishing both inside and outside the community boundary

CBNRM had a negative impact on adult equivalent consumption in Chivieng community (Table 6). The results from Kernel, nearest neighbor and radius matching methods show that the amount of adult equivalent consumption in Chivieng community was lower than Preak Sromoach community which is USD 30, USD 25 and USD 15 per month respectively.

TABLE 3 Covariate balance across treatment and control groups for the households fishing only inside the community boundary

Methods	*Total samples*	*No. of treatment observations*	*No. of control observations*	*Mean Std. diff. in covariates (%)*	*Median Std.diff. in covariates (%)*
Original samples	348	192	156	11.8	7.7
Kernel matching	348	192	156	3.4	2.4
Nearest neighbor matching*	348	192	156	1.7	0.9
Nearest neighbor matching**	348	192	156	2.1	1.7
Radius matching	348	192	156	1.8	1.7

**without replacement, ** with replacement*

TABLE 4 Descriptive statistics for the household respondents fishing only inside the community boundary and those fishing both inside and outside the community boundary.

Variable			*Mean number (Range)*	
			Control (239)	*Treatment (232)*
Dependent	Adult equivalent consumption (US dollar/month)		91.21 (22.53–377.58)	80.91 (18.5–271.37)
Independent Continuous	Age		39.28 (20–77)	40.77 (20–68)
	Education		2.35 (0–8)	2.1 (0–12)
	Household size		5.15 (1–10)	4.07 (1–11)
Independent Categorical	Gender	Male	199	196
		Female	32	44
	Education × Gender	No education	220	204
		Studying one year at school	11	36

TABLE 5 Descriptive statistics for the household respondents fishing only inside the community boundary

Variable			*Mean number (Range)*	
			Control (192)	*Treatment (156)*
Dependent	Adult equivalent consumption (US dollar/month)		33.95 (12.51 – 110)	56.4 (15.57 – 138)
Independent Continuous	Age		39.84 (20 – 68)	40.58 (20 – 77)
	Education		1.81 (0 – 7)	1.92 (0 – 7)
	Household size		2.4 (1 – 8)	2.3 (1 – 8)
Independent Categorical	Gender	Male	159	128
		Female	32	29
	Education × Gender	No education	171	143
		Studying one year at school	21	13

TABLE 6 Impact of CBNRM on the household adult equivalent consumption of those fishing only inside the community boundary and the households fishing both inside and outside the community boundary

Method		*Average treatment effect on treated (ATT)*	*AI Robust Standard Error*	*T-statistics*	*P values*
Kernel		- 30.23	6.68	- 5.28	< 0.01
Nearest Neighbor	Without replacement	- 26.12	7.74	- 1.68	<0.1
	With replacement (N=5)	- 25.63	7.74	- 2.03	<0.05
Radius		- 14.68	5.59	- 6.67	<0.01
Sensitivity analysis (Γ)			2.4		

Several previous studies (e.g. Adhikari 2005; Mohsin *et al.* 2009; Bandyopadhyay and Tembo 2010; Silva and Mosimane 2012) described a positive impact of CBNRM on poverty reduction including household consumption but a negative impact was recorded in the present study. There were two reasons explaining the negative impact of CBNRM on household adult equivalent consumption: 1) limited property rights to exclude migrant fishermen and enforce the laws on the people doing illegal fishing activities, and 2) ineffective alternative livelihood source created by the CBNRM, ecotourism. According to the first reason, the households in Chivieng community could not gain the desired benefits in spite of their efforts in resource management (establishment of the conservation area, patrolling, and replanting flooded forests). This was because they had to compete daily with the migrant fishermen from outside the community who came to fish inside their community boundary and that the households in the community did not have any authority to restrict the migrant fishermen from fishing inside the community or punish them for their illegal fishing activities. The migrant fishermen often came to fish inside Chivieng community because of the well-protected fishery resources. Seventy-nine percent of the household respondents in Chivieng community claimed that most of fishermen catching fish in the community boundary were outsiders, while only 45% of the household respondents in Preak Sromoach community claimed that there were not many migrant fishermen fishing inside the community boundary. Theoretically, according to the eight design principles of Ostrom (1990), the local community can manage their resources successfully when a local community have enough property rights, which also includes the rights to exclude the non-members or outsiders from extracting their resources and the rights to enforce their community's rules. In inshore fishery resource management, the rights to exclude the migrant fishermen or punish them for their illegal fishing activities are considered a main mechanism to protect the benefits that the households in the community should get from their efforts in resource management (Pinkerton and Weinstein 1995). A similar study conducted in Chile (Gelcich *et al.* 2005) did not focus on its impact on household consumption but it revealed that the local artisanal fishermen who used to compete with the migrant fishermen in fishing activities before co-management implementation strongly expected economic success from the management, which was partly due to their rights to exclude the migrant fishermen from their community. Despite differences in types of natural resource management, the previous studies mentioned earlier who found positive impact of CBNRM on either household consumption or income also implicitly indicated that the positive impact of CBNRM was due to the fact that the people in the CBNRM-implemented communities had the right to exclude the outsiders from extracting the resources in their communities as well as the right to punish those who extracted the resources illegally.

The ineffectiveness of ecotourism in Chivieng community is another issue which was created as an alternative source of livelihoods by CBNRM. The financial benefits from ecotourism to the households in the community were very limited because of the seasonal nature of the activities. Only three percent of the total households engaged in ecotourism-related jobs. The average income was 100 USD during the peak season that lasted only three months from October to December. Ecotourism-related jobs included a provision of services to the tourists in the form of accommodation, cooking, boat operation and selling handicraft made from hyacinth. According to Ostrom (1990), in theory resource management by the local community including CBNRM cannot be successful without alternative sources of income. The alternative sources of income are not only an incentive for the local community to reduce their efforts in resource extraction, but also an important means to improve their livelihoods and reduce poverty. However, it is also stated that those alternative sources of income should be enough to enable the local community to improve their livelihoods and also reduce their efforts in resource extraction. If the income from these sources is not significant for their livelihoods, poverty reduction and resource conservation cannot be achieved. A study in Namibia (Suich 2013) revealed that although CBNRM provided financial benefits to the people living in CBNRM-implemented communities, those financial benefits were so few and did not significantly increase income or consumption of the households in the community.

3.2.2 | Impact of CBNRM on adult equivalent consumption of the household respondents dependent on fishery resources inside the community boundary

CBNRM positively affected adult equivalent consumption of the household respondents who fished only inside the community boundary (Table 7). The finding here, the positive impact of CBNRM on adult equivalent consumption of the household respondents who fished only inside the community boundary in Chivieng community, was in contrast to the negative impact of CBNRM on adult equivalent consumption of the household respondents who fished only inside the community boundary and the household respondents who fished both inside and outside the community boundary. The amount of adult equivalent consumption of the household respondents in Chivieng community was higher than that in Preak Sromoach community, around USD 43 for Kenel and Radius matching methods, and approximately USD 58 and USD 50 for Nearest Neighbor matching without and with replacement, respectively.

TABLE 7 Impact of CBNRM on the household adult equivalent consumption of the households fishing only inside the community boundary

Method		*Average treatment effect on treated (ATT)*	*AI Robust Standard Error*	*T-statistics*	*P values*
Kernel		42.69	4.26	10.53	<0.01
Nearest Neighbor	Without replacement	58.42	4.13	11.75	<0.01
	With replacement (N=5)	49.49	4.13	11.76	<0.01
Radius		43.13	3.82	11.14	<0.01
Sensitivity analysis (Γ)			1.8		

There were two reasons that likely explained the positive impact of CBNRM on the adult equivalent consumption household respondents who fished only inside the community boundary. Firstly, CBNRM was congruent with the conditions in Chivieng community in terms of access to NTFPs. Congruence with local conditions is one of the eight design principles suggested by Ostrom (1990) to manage common property resources successfully. According to the FDGs, key informant interviews, as well as household interviews in Chivieng community, CBNRM did not change any rules in access to NTFPs that were used in the community before CBNRM implementation. Before CBNRM implementation, i.e. when TSL was under the management of the commercial fishing lot system, the households in Chivieng community could freely access and make use of NTFPs for household consumption. After CBNRM implementation, they still could access and make use of NTFPs for their household consumption without any restriction imposed by CBNRM. As a result, CBNRM did not affect adult equivalent consumption in NTFPs. Some previous studies found that the local communities had lost access to the natural resources including NTFPs in their community because a new resource management system established and imposed new rules that were not congruent with the local social conditions. The study conducted by Gelcich *et al.* (2006) in inshore fishery management system in Chile found that Management and Exploitation Areas for Benthic Resources (MEABR) policy, based on concepts of co-management, established new rules to access bull-kelp that were not congruent with the fishermen' lifestyle and affected their rights to access the bull-kelp as well as their income and consumption. Before policy implementation, the fishermen accessed the bull-kelp by using lottery system awarding for annual access to harvesting ground and harvesting the bull-kelp was also season based. However, after the policy implementation, the access to the bull-kelp was changed. The fishermen had to face with bureaucracy imposed by MEABR to obtain the harvesting ground and had to spend money on hiring consultants before harvesting the bull-kelp; consequently, the income that the fishermen earned from selling the bull-kelp was used to spend on administrative costs and consultancy services.

Secondly, the households in Chivieng community had better knowledge of their rights to access NTFPs than those in Preak Sromoach community. Their knowledge was gained from the trainings provided by the CBNRM committee members while the households in Preak Sromoach community were deprived of the knowledge due to lack of such trainings. According to FDGs and key informant interviews, there were at least five times trainings per year conducted in Chivieng community by the CBNRM committee members excluding those conducted by the local government officials, while there were only two trainings per year in Preak Sromoach community conducted only by the local government officials. The content of the trainings was about the rights of the local people to access and use the natural resources including NTFPs in the community. This reason was also supported by the significantly higher frequency of NTFPs collection of the households in Chivieng community than that of those in Preak Sromoach community. According to the face to face interview, 90% of the households in Chivieng community who fished inside the community went to collect NTFPs inside the flooded forest more than twice per week, while only 29% of the households in Preak Sromoach community who fished inside the community went to collect them only once per month. Whether significantly high NTFP collection in Chivieng community was due to the abundance of NTFPs as a result of CBNRM activities of protection and replanting of flooded forests is beyond the scope of the present study.

4 | CONCLUSION

Even though CBNRM did not positively affect the household consumption in Chivieng community as a whole, it did for the households who fished only inside the community boundary. It is clear that CBNRM in TSL yet not reached to a level that can improve the household consumption in the community and its impacts are still limited to a certain group of the households in the community. In order to improve household consumption, CBNRM needs to work on two aspects. Firstly, more property rights should be given to the CBNRM-implemented communities, in particular, the rights to exclude the migrant fishermen and the rights enforce their bylaws and inter-

nal regulations. Consequently, they can appropriate the benefits from their effort to manage fishery resources without competition with the migrant fishermen. Secondly, besides ecotourism, more alternative sources of income should be created so as to reduce dependency on fishery resources, which may also make them less dependent on the resources and competition in fishing. Additional alternative sources of income can be created by expanding the market of the existing ecotourism-relate job, that is, hyacinth-made handicraft not only to the tourists coming to visit in the community, but also to the people in the other areas of the country in the particular in the capital cities like Phnom Penh.

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REFERENCES

Adhikari B (2005) Poverty, property rights and collective action: Understanding the distributive aspects of common property resource management. Environment and Development Economics 10(01): 7–31. doi: 10.1017/S1355770X04001755

Agrawal A and Gupta K (2005) Decentralization and Participation: The Governance of Common Pool Resources in Nepal's Terai. World Development 33(7): 1101–1114. doi: 10.1016/j.worlddev.2005.04.009

Agrawal A and Ostrom E (2001) Collective Action, Property Rights, and Decentralization in Resource Use in India and Nepal. Politics & Society 29(4): 485–514. doi: 10.1177/0032329201029004002

Araral E (2014) Ostrom, Hardin and the commons: A critical appreciation and a revisionist view. Environmental Science & Policy 36: 11–23. doi: 10.1016/j.envsci.2013.07.011

Bandyopadhyay S and Tembo G (2010) Household Consumption and Natural Resource Management around National Parks in Zambia. Journal of Natural Resources Policy Research 2(1): 39–55. doi: 10.1080/19390450903350838

Becker SO and Ichino A (2002) Estimation of average treatment effects based on propensity scores. Stata Journal 2(4): 358–377.

Bertoli S and Marchetta F (2014) Migration, Remittances and Poverty in Ecuador. The Journal of Development Studies 50(8): 1067–1089. doi: 10.1080/00220388.2014.919382

Clement M (2011) Remittances and Household Expenditure Patterns in Tajikistan: A Propensity Score Matching Analysis by Matthieu Clement. Asian Development Review 28(2): 58–87. doi: 10.2139/ssm.2001145

Galib SM (2015) Fish fauna of the Brahmaputra River, Bangladesh: richness, threats and conservation needs. Journal of Fisheries 3(3): 285–292. doi: 10.17017/jfish.v3i3.2015.120

Galib SM, Rashid MA, Chaki N, Mohsin ABM and Joadder MAR (2016) Seasonal variation and community structure of fishes in the Mahananda River with special reference to conservation issues. Journal of Fisheries 4(1): 325–334. doi: 10.17017/jfish.v4i1.2016.139

Galib SM, Samad MA, Hossain MA, Mohsin ABM and Haque SMM (2010) Small Indigenous Species of Fishes (SISF) in Chalan Beel with reference to their harvesting and marketing. Bangladesh Journal of Progressive Science and Technology 8(2): 251-254.

Gelcich S, Edwards-Jones G and Kaiser MJ (2005) Importance of Attitudinal Differences among Artisanal Fishers toward Co-Management and Conservation of Marine Resources. Conservation Biology 19(3): 865–875. doi: 10.1111/j.1523-1739.2005.00534.x

Gelcich S, Edwards-Jones G, Kaiser MJ and Castilla JC (2006) Co-management Policy Can Reduce Resilience in Traditionally Managed Marine Ecosystems. Ecosystems 9(6): 951–966. doi: 10.1007/s10021-005-0007-8

Haughton JH and Khandker SR (2009) Handbook on Poverty and Inequality. World Bank Publications, Washington.

Heckman JJ, Lalonde RJ and Smith JA (1999) The Economics and Econometrics of Active Labor Market Programs. Handbook of Labor Economics 3: 1865–2097. doi: 10.1016/S1573-4463(99)03012-6

Joadder MAR, Galib SM, Haque SMM and Chaki N (2015) Fishes of the river Padma, Bangladesh: current trend and conservation status. Journal of Fisheries 3(2): 259–266. doi: 10.17017/jfish.v3i2.2015.111

Jones RW and Sok S (2015) Impacts and Implications of Deep Fisheries Reforms on the Governability of Small-Scale Fisheries in Tonle Sap Lake, Cambodia. In S. Jentoft and R. Chuenpagdee (eds.), Interactive Governance for Small-Scale Fisheries. Springer International Publishing pp. 539–557.

Keskinen M (2006) The Lake with Floating Villages: Socio-economic Analysis of the Tonle Sap Lake. International Journal of Water Resources Development 22(3): 463–480. doi: 10.1080/07900620500482568

Khan MA, Alam MF and Islam KJ (2012) The impact of co-management on household income and expenditure: An empirical analysis of common property fishery resource management in Bangladesh. Ocean & Coastal Management 65: 67–78. doi: 10.1016/j.ocecoaman.2012.04.014

Lee WS (2011) Propensity score matching and variations on the balancing test. Empirical Economics 44(1): 47–80. doi: 10.1007/s00181-011-0481-0

Maddala GS (1986) Limited-Dependent and Qualitative Variables in Econometrics. Cambridge University Press.

Mak S (2011) Political Geographies of the Tonle Sap: Power, Space and Resources. National University of Singapore. scholarbank.nus.edu.sg/bitstream/handle/10635/30255/Final%20PhD%20Thesis_Mak%20Sithirith.pdf?sequence=1, accessed on 24 May 2013.

Mohsin ABM, Hasan MM and Galib SM (2009) Fish diversity of community based fisheries managed oxbow lake (Bookbhara Baor) in Jessore, Bangladesh. Journal of Science Foundation 7(1): 121–125.

Nuon V and Gallardo W (2011) Perceptions of the local community on the outcome of community fishery management in Krala Peah village, Cambodia. International Journal of Sustainable Development & World Ecology 18(5): 453–460. doi: 10.1080/13504509.2011.584199

Ostrom E (1990) Governing the Commons. Cambridge University Press, Cambridge.

Pinkerton E and Weinstein M (1995) Fisheries That Work: Sustainability through Community-Based Management. David Suzuki Foundation, Canada.

Rosenbaum PR (2002) Observational Studies. Springer, New York.

Rosenbaum PR and Rubin DB (1983) The central role of the propensity score in observational studies for causal effects. Biometrika 70(1): 41–55. doi: 10.2307/2335942

Silva JA and Mosimane AW (2012) Conservation-Based Rural Development in Namibia: A Mixed-Methods Assessment of Economic Benefits. The Journal of Environment & Development 20(10): 1-26. doi: 10.1177/1070496512469193

Smith JA and Todd PE (2005) Does matching overcome LaLonde's critique of nonexperimental estimators? Journal of Econometrics 125(1–2): 305–353. doi: 10.1016/j.jeconom.2004.04.011

Suich H (2013) Evaluating the household level outcomes of community based natural resource management: The Tchuma Tchato Project and Kwandu Conservancy. Ecology and Society 18(4): 25. doi: 10.5751/ES-05875-180425

Thol D and Sato J (2014) Is Greater Fishery Access Better for the Poor? Explaining De-Territorialisation of the Tonle Sap, Cambodia. Journal of Development Studies 50(7): 962–976. doi: 10.1080/00220388.2014.909027