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A Multi-Tier Social-Ecological System Analysis of Protected Areas Co-Management in Belize

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Abstract: Co-management of protected areas has been recognized as a viable option to sustainably manage ecosystems. This collaborative approach actively engages civil society in the protected areas governance processes. Attempts at co-management, however, have not been uniformly successful; whereas the governance of some initiatives succeed and become strong and sustainable, others become weak or fail over time. In this paper, we provide a nuanced application of Ostrom's multi-tier SES framework to carry out a systematic analysis of representative cases of co-management in Belize. This novel approach allows us to avoid the common problem of overstating the explanatory power of individual variables, while enabling us to tease out the interrelationships among critical process and contextual variables that may influence co-management outcomes. Our findings show that strong co-management is associated with a multiplicity of variables, including information sharing, conflict resolution, investments, self-organization, and networking. Contextual conditions inclusive of strong leadership, social capital, and high levels of dependence on resources for daily livelihoods seem to have influenced these processes over time. The presence of cross-scale and cross-level networks also seems to be important in influencing co-management outcomes. Our study contributes to the further development of Ostrom's multi-tier SES framework by proposing the addition of five new third-tier variables. We advance some key lessons in the analysis of co-management outcomes and offer some policy recommendations to improve protected areas co-management policy and practice in Belize.

Keywords: Belize; co-management; commons; protected areas; SES framework

1. Introduction

Humans' increasing demands on Earth's natural systems have engendered more significant pressures on ecosystems over the last few decades than any comparable time in history [1,2]. These pressures continue to lead social and ecological systems towards unsustainable trajectories. Theoretical research and empirical studies have fostered two major conclusions in sustainability science. First, scholars now recognize that environmental challenges are complex and non-linear and, as such, efforts to address these problems must embrace complexity and change [3,4]. Second, social and ecological systems are connected systems with multiple interactions and feedbacks at various spatial and temporal levels and scales [5,6]. As such, efforts to achieving sustainability will require innovation, foresight, and collaboration between state and non-state actors. The Millennium Ecosystem Assessment (MEA) Report ([1] p. 18) posits that *"although most ecosystem services assessed in the millennium assessment are being degraded, the extent of that degradation would have been much greater without responses implemented in past decades"*.

Protected areas, one such approach highlighted by the MEA, have been established as "complementary measures" to foster the sustainability of ecosystem services in response to increasing

anthropogenic threats to natural ecosystem [7]. Evolving from the mere spaces to protect biodiversity, protected areas are now recognized as additionally having important social dimensions, such as contributing to local and national development, poverty reduction, and livelihood sustainability [8–10]. As such, initiatives to sustainably govern protected areas must take into account these complexities. Co-management, one mechanism of sustainable governance, has been shown to be a viable alternative to centralized bureaucratic governance approaches [11–14]. Co-management has evolved from mere power sharing arrangements between governments and local communities to dynamic cross-scale and cross-level institutional structures and processes characteristic of complex SES [11,13]. Such approaches continue to be recognized as a crucial dimension in contributing to, *inter alia*, social and economic development, deliberation, power sharing, and conflict resolution [11,15]. Even with such positive trends in protected areas governance, however, the devolution of powers to local communities in the co-management of protected areas has not been uniformly successful. Some initiatives to govern protected areas have resulted in successful outcomes, whereas others have become weak or failed in the long run [16,17].

A major challenge in discerning factors influencing co-management outcomes is that many studies which attempted to identify attributes which foster strong co-management initiatives lacked a systematic framework to guide their analysis. Others merely carried out static reviews of protected areas governance by analyzing selected attributes (or variables) influencing co-management outcomes. Pomeroy *et al.* [14], Rashid *et al.* [16], and Basurto and Jimenez [17], for instance, identified a suite of variables influencing strong or weak co-management without any systematic framework guiding variable selection. Additionally many studies fail to address the dynamic interlinkages among factors influencing co-management [17–19]. The problem, argues Evans *et al.* ([18] p. 1947) is that “most existing assessments present a diverse array of indicators and data types that are difficult to compare across cases, countries, and regions”. The absence of a systematic framework also makes these findings difficult to compare across cases to effectively inform co-management theory and practice. Determining the factors influencing protected areas governance outcomes requires a critical understanding of how outcomes are associated with particular institutional and contextual conditions and their cross-scale and cross-level interrelationships [19].

Of the 48 protected areas under co-management in Belize (representing just under 50% of all protected areas) some have developed into strong initiatives providing socio-economic benefits to local communities, built strong collaborative multi-level and multi-scale governance institutions, and maintained self-organization to foster co-management over time. On the other hand, some initiatives have failed to maintain self-organization, build collaborative governance institutions and, thus, foster co-management [20,21]. What explains the different trajectories of outcomes? How can we understand the conditions that influence protected areas co-management outcomes to improve policy and practice? In this paper, we apply Ostrom’s multi-tier SES framework [22,23] to carry out a dynamic diagnosis of two cases of protected areas co-management in Belize: Sarstoon Temash and Mayflower Bocawina national parks. These sites represent a microcosm of the state of protected areas co-management in Belize. National studies on management effectiveness in 2006 and 2009 graded Sarstoon Temash National Park as performing very well and Mayflower Bocawina as performing poorly in managing respective protected areas [20,21]. Both initiatives have formal co-management agreements since 2003 and both are community-based initiatives. We are particularly interested in the unfolding patterns of interactions and contextual conditions influencing co-management from inception in 2003 up until 2014—the time of this study.

The interdisciplinary framework provides a common analytical language to diagnose outcomes in common-pool resources (CPR) governance at various levels and scales [24–26] and its diagnostic nature helps scholars to identify unique variables present in each case and also makes for more accurate comparisons across cases [24]. Few studies, however, have applied the SES framework to diagnose outcomes in co-management initiatives [18,19,27]. Furthermore, no study has applied the framework to diagnose differing outcomes in protected areas co-management.

As a point of departure, we first review the theoretical framework that guides our analysis. Next, we briefly review our methodology and some limitations of the study. Thereafter, we present our cases and demonstrate how we apply the multi-tier SES diagnostic framework to tease out context and process variables and their interrelationships in influencing co-management outcomes. We then present the results of our analysis and engage in a discussion about these findings. We conclude by summarizing the implications of our study and advance policy recommendations for protected areas co-management policy and practice in Belize.

2. Co-Management: A Retrospect

Co-management (also referred to as collaborative, joint, or participatory management) provides an alternative to monocentric, top-down, bureaucratic governance of natural resources. There is no single definition of co-management [11,28] or singular arrangement under which co-management is optimally exercised [29,30]. Rather, authority and responsibility sharing in co-management occurs on a spectrum of arrangements [28,30] and spheres of cooperation, authority, and power-sharing are not always clear [18]. In co-management, emphasis is placed on negotiation, problem-solving, shared functions, and responsibilities and joint learning. Carlsson and Berkes ([31] p. 65) caution, however, against “*over-emphasizing the formal aspect of such power sharing arrangements*” which can lead to “*disregarding the functional side of co-management*”. Co-management in this view is to be understood as a continuous process of deliberation and negotiation, knowledge generation, networking, and power-sharing [11].

The literature on co-management is largely encompassed in CPR theory. Extensive empirical studies have helped to build theories of collective action and improve our knowledge of conditions influencing collective action in communities and their ability to self-organize and govern local resources [24,25,32,33]. Scholarship on various institutional arrangements and their influence on collective action outcomes in commons resources exists in the literature, including forestry [34,35], fisheries [32,36,37], watershed [38–40], and multiple-resources governance [12,32,41–43]. Multiple contexts and process variables that potentially influence outcomes of co-management, either positively or negatively, have been identified by empirical and meta-analyses, as highlighted in Table S1 [12,13,19,27,30,44,45]. Here, we review a subset of variables (conceptualized as institutions and processes) and their interactions that can potentially influence co-management outcomes.

Leaders and their leadership styles play a critical role in the co-management process. The presence of strong dedicated leaders with prior technical knowledge in resource management and project management to drive self-organization, innovation, collaboration, and networking can contribute to successful co-management outcomes [5,13,23,46]. In a meta-analysis of 130 cases of artisanal and industrial fisheries, Gutiérrez *et al.* [27] found the presence of strong leadership to be the most influential of 19 variables associated with co-management success. They posit that “*[the] presence of at least one singular individual with entrepreneurial skills, highly motivated, respected as a local leader and making a personal commitment to the co-management implementation process was essential*” to co-management success ([27] p. 387). In case studies from Sweden and Canada Olsson *et al.* [5] found that local leaders played a pivotal role in leading self-organization, strengthening community-based organizations (CBOs), and building vertical and horizontal linkages.

Leaders provide the agency to build social capital so as to increase legitimacy, trust, and cooperation in the co-management process [47]. Strong social capital, often articulated through cohesion, norms, social networks, trust, and reciprocity, can help to facilitate the co-management process and positively influence success by reducing transaction costs through increased cooperation [19,23,48,49]. Such an environment of trust and reciprocity provides the incentives for individuals, households, and organizations to participate with the confidence that others will also cooperate [11,48]. In this regard, Gutiérrez *et al.* ([27] p. 333) argue that strong group cohesion can help “*serve as a buffer against changes in institutional arrangements, economic crises and resource overexploitation, and foster sustainable co-management systems*”. Social capital, as interpreted

by Putnam [50], can facilitate key processes and activities such as networking, conflict resolution, monitoring, and information sharing, thereby contributing to successful co-management outcomes [51]. In a review of potential variables affecting collective action in lake restoration in India, Nagendra and Ostrom [25] found that successful cases of collective action in lake restoration were represented by high levels of group cohesion; conversely, this social capital was generally low to moderate in weak cases. As such, they [25] concluded that, in their study, low social capital served as a potential barrier to collective action and, thus, successful lake restoration.

Individuals, community groups, government organizations, and international organizations all share some interest in protecting natural resources and the sustainability of ecosystem services. Strong cross-scale and cross-level networks can connect various stakeholder interests, knowledge, and resources for collective actions around resources management [52–54]. Through processes of networking stakeholders can collaborate, share information, resolve conflicts, and build social cohesion. Bodin and Prell ([55] p. xiii) argues that “*social networks are often the glue that ties together the individual with the organizational and the institutional and with key actors operating in networks that span multiple scales and governance levels*”.

An often critical partner in co-management success are external agents or bridging organizations. Bridging organizations, such as international and local non-government organizations (NGOs), academic institutions, and religious organizations, are often important building blocks to foster co-management [13]. These external agents aid in establishing baseline planning, research, capacity-building, problem-solving, cross-scale and cross-level collaboration, learning, and trust-building [13,51,56,57]. Bridging organizations serve the linking function between government and local communities through which processes of trust building, learning, information sharing, and others occur [56]. In Sweden, for instance, the Ecomuseum Kristianstads Vattenrike (EKV) played a key role in facilitating and sustaining co-management of the Kristianstads Vattenrike Biosphere Reserve [58]. The EKV helped to build trust, co-produce knowledge, and provide conflict resolution mechanisms by linking various local groups, bird conservation organizations, farmers, and international conservation organizations in addressing issues of declining bird populations, low water quality, and lake overgrowth.

Dependence on local resources can also serve as an important incentive for collective action. In their decision to join collective action strategies, users analyze the costs and perceived benefits [32]. Ostrom [23] posits that in successful cases of collective action and self-organization, resource users often have a high dependence on local resources for their livelihoods. As such, resource dependence can serve as a key driver for participation in co-management. In a review of three fishing communities in Mexico, Basurto *et al.* [24] found that high levels of short- and long-term dependence on local fisheries served as an important incentive for local communities to organize to sustainably manage fishery resources. Several other scholars have highlighted the important role that incentives such as access to resources and alternative livelihood programs play in facilitating users’ engagement in collective strategies in resources governance [19,27,28,32]. While these processes and institutions, and their interactions, can help to improve co-management outcomes, they also share flaws inherent to CPR governance. Bodin and Crona [47], for example, found that strong group cohesion can facilitate weak reporting of rule breakers, thus resulting in perverse outcomes of strong social capital. There are also strong possibilities of free-riding by some community members. Some communities may also make decisions that maximize present benefits at the expense of future resource sustainability [48,59]. In addition, some empirical studies have found that co-management can contribute to increasing social inequities by marginalizing the poor and benefiting primarily the local elite [11,19].

3. Multi-Tier SES Framework

Over the years, the development of basic and applied knowledge in SES has been lacking a common classificatory framework. Ostrom ([23] p. 420) argues that “*a core challenge in diagnosing why some SESs are sustainable, whereas others collapse is the identification and analysis of relationships among*

levels of these complex systems at different spatial and temporal scales". The multi-tier SES framework seeks to address this core challenge by providing a common set of variables that can be used to analyze patterns of interactions and outcomes in complex SES. This framework provides a broad map encompassing a range of possible explanatory variables and sub-variables that can be used to answer questions of self-organization and the sustainability of governance institutions in managing commons resources [26]. The diagnostic nature of the framework allows for careful analysis of empirical cases across differing geographic contexts and in varied settings, at levels of generality or specificity as needed [60]. Ostrom ([23] p. 420) makes the point that "[w]ithout a framework to organize relevant variables identified in theories and empirical research, isolated knowledge acquired from studies of diverse resource systems in different countries by biophysical and social scientists is not likely to cumulate". The SES framework incorporates the theoretical underpinnings of collective action and CPRs which have aided scholars in understanding collective action problems and the sustainability of governance institutions [24,61,62]. Initially developed by Ostrom [8], the SES framework encompasses more than 30 years of research on CPRs [24,63] and continues to be strengthened through empirical studies and theoretical developments made by scholars in The Ostrom Workshop, as well as others involved in CPRs governance studies [26].

At the core of the SES framework (Figure 1) are the focal action situations: patterns of interactions (I) (extractions and maintenance) and outcomes (O) (performance of focal SES). Actors (A) make particular cost-benefit choices to participate in collective action based on their knowledge of other users and the larger context of participation. These actors are guided by governance institutions at various hierarchical levels prohibiting, permitting, or requiring their participation (GS) which influences collective action outcomes. Focal action situations are influenced by actors who extract or modify resource units (RU) (fish, trees, water, and ecosystem services) from the larger resource systems (RS) (rivers, forests, and watershed). These variables interacting over time are also influenced by, and create feedback to, the external social, political, and economic environment (S) and related ecosystems (ECO) [24]. This broad set of first-tier variables can be broken down into second, third, fourth, and fifth tiers depending on the needs of the analyst. We apply the term "tier" here to highlight "levels" or "ranking" of variables. As such, governance system—a first-tier variable—is composed of lower tiers of variables such as government organizations and non-government organizations. Second-tier variables—such as NGO—can, themselves, be unpacked further into third-, fourth-, and fifth-tier variables. By variables here, we refer to attributes or components of the resource system, governance system, resource units, actors, interactions, and outcomes.

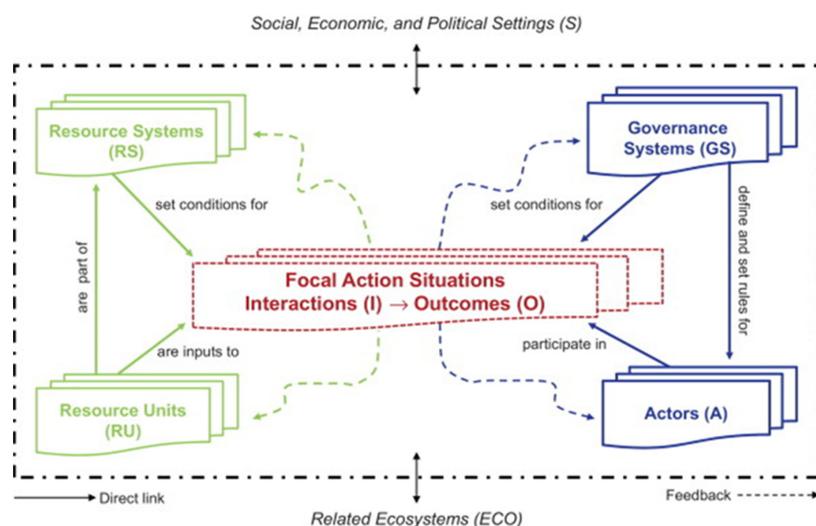


Figure 1. Multi-tier Framework for Analyzing a Social Ecological System. “Reproduced with permission from McGinnis and Ostrom, Social-ecological System Framework: Initial Changes and Continuing Challenges; published by Ecology and Society 2014”.

The multi-tier framework does not advance any particular combination of variables to explain success or failure in commons governance but instead presents a more comprehensive representation of possible explanatory variables [64]. (See McGinnis and Ostrom [26] for a broad list of first- and second-tier variables). As per its diagnostic nature, studies need only apply specific variables (identified either through knowledge of the SES being studied or through past research) when applying the SES framework [64]. A scholar can then take into account various combinations of first and second tier variables and then expand further to include third and fourth tier variables depending on the objective of the study [24]. This dynamic utility of the multi-tier SES framework has been successfully applied by scholars to answer a variety of questions in self-organization and the sustainability of community institutions in forest [65], water [46,66] fisheries [24,61], and tourism [67] management.

4. Methods

In this study we analyze process and contextual variables associated with protected areas co-management outcomes for two representative cases in Belize. As a point of departure, we define our outcome variable (O1) as a strong or weak protected area co-management initiative. We define the strong initiative as having collaborative, multi-level, and multi-scalar processes of institution-building, as well as providing socio-economic benefits to local communities through co-management. Conversely, the weak initiative is defined as having weak governance structures and limited networks to strengthen protected areas co-management. The weak initiative also failed to maintain self-organization and other critical processes throughout co-management and failed to provide socio-economic benefits to local communities.

4.1. Sites Selection

To select our representative strong and weak cases for diagnosis, we engaged the Status of Protected Areas in Belize Report 2009 [21]. The Report provided a review of protected areas management effectiveness in Belize in 2009 using the Monitoring Package for Assessing Management of Protected Areas. The study rated our strong case as performing very well with a site score of 3.5 out of a possible 4.0. Our weak case was rated as performing poor with a score of less than 2.0.

Table 1 provides a synoptic overview of both cases. In both representative cases, the Government of Belize and a community-based organization have signed a co-management agreement to govern their respective local protected area. Both protected areas are IUCN category II with the aim of protecting natural biodiversity and associated ecosystem services while taking into account the needs of local communities. Population sizes of adjacent communities in both the strong and weak cases are relatively similar; however, as the strong case represents a significantly larger protected area, the population density is much lower. There are also differences in use of resources between these two cases (Table 1). From our prior knowledge of the Belize protected areas system and our previous experience in working with these two cases, we concluded that these sites would be apt for our analysis.

Table 1. General characteristics of cases.

	Sarstoon Temash (Strong Case)	Mayflower Bocawina (Weak Case)
Protected area type (IUCN)	Cat. II-National Park	Cat. II-National Park
Size of protected area	16,938 hectares	3000 hectares
Year of establishment	1994	2001
Year of co-management	2003	2003
No. of primary buffer villages	5	1
Mean population per village	200	900
Livelihood	Subsistence agriculture	Agro-Industry and Blue collar

4.2. Variable Selection

We carried out a careful literature review of existing research analyzing key variables affecting co-management outcomes. Agrawal [33], for example, identified more than 30 contextual and process variables that affect users' self-organization to collectively govern resources. Based on our literature review, we extracted a total of 20 second-tier variables from four broad first-tier variables (*resource system, governance system, actors, and interactions*) of the SES framework. We then established a working definition for each of the 20 variables to further guide our selection of variables to be used in our study. Aided by a further literature review and from our prior knowledge of the Mayflower Bocawina and Sarstoon Temash cases, our initial set of 20 second-tier variables were narrowed to a subset of 11 variables. From the first-tier variable governance system (GS), we selected three second-tier variables: government organizations (GS1), non-government organizations (NGOs) (GS2), and network structure (GS3). From the actor (A) variables we selected: leadership (A5), social capital (A6), and dependence on resources (A8). Lastly, from the interactions (I) variables we selected: information sharing (I2), conflict resolution (I4), investment activities (I5), self-organizing activities (I7), and networking activities (I9). In both cases, the ecological sub-system largely encompass national parks sharing similar multiplicity of resource systems (RS) and resource units (RU) (forest, fisheries, watershed), thus having no major variation across cases. In addition, no long-term assessments have been carried out to assess ecological changes in both protected areas throughout the period of co-management. Rapid ecological assessments were carried out at the time CBOs assumed co-management, but no subsequent comprehensive ecological studies have been carried out to compare against those baseline data. As a result, we did not select any distinctive resource system (RS) or resource units (RU) variables from the framework as there was no significant variation across protected areas. Further, since both sites are within Belize, we did not select any variable of macro social, political, and economic settings (S).

Finally, through additional literature review and initial field work, we added five new third-tier variables not present in the framework to further guide our analysis: government departments, quasi-government organizations (government funded institutions administered by a private-government Board of Directors), international NGOs, national NGOs, and CBOs. We present a comprehensive list of variables, working definitions, reason for exclusion of particular variables, and references which guided variable inclusion or exclusion in our study in Table S1.

4.3. Data Collection and Analysis

Our field approach was primarily qualitative. Field data collection was carried out during field visits from June–September 2013 and February–September 2014. Using a snowball method, we conducted 64 unstructured and semi-structured interviews (41 in Sarstoon; 23 in Mayflower) with key informants, including village chairpersons, elders, religious leaders, village groups, co-managing agency staff, government officials in the Forest Department, funding agencies, and officials of other key organizations. In addition, three focus group sessions were held: two in Sarstoon Temash encompassing five adjacent villages, and one in the Mayflower Bocawina border village. Focus group discussions targeting key community members served to establish historical evolutionary governance processes, community interactions, and resource use throughout co-management. To observe key processes of the interactions of residents in governance and resource settings, we carried out participatory and independent observations. We also carried out a review of grey literature including annual reports, management and strategic plans of the co-managing agencies, and ecological and social assessments to inform our analysis.

In analyzing our data we primarily use qualitative content analysis to code data and analyze themes and patterns from the literature and from our field data. Prior to fieldwork, we developed an initial set of 11 codes based on our selected variables of the SES framework to aid in data reduction after interviews. After our initial field visit in 2013 and further literature review, we expanded our list to include 16 codes and 40 sub-codes (See Table S2). With coding we were able to reduce, as well as

re-conceptualize, our data. These analytical methods aided in identify patterns of interactions and unfolding resource use and draw inferences on co-management outcomes. In analyzing the variable information sharing (I2), for example, we analyzed number of meetings, radio-shows, flyers, and other communicative media used to disseminate information to local communities and other stakeholders about the protected area. Frequent use of one or more of these communicative media would indicate high levels of information sharing. To discern leadership (A5) strength and its association with co-management outcomes, we analyzed leadership presence and quality over time. As such, strong leadership was inferred by (i) presence of an individual or group of individuals leading collective action to nurture and strengthen co-management and (ii) the presence of initiatives led by an individual or group of individuals to build networks to leverage resources to (a) improve protected areas management and (b) to provide socio-economic benefits to local communities. Thus, we are able to infer and draw conclusions when we analyze each variable or attribute and their patterns of interactions from co-management inception to time of fieldwork.

While the purposive sample of our two sites provide some sampling bias, these two cases allowed an opportunity to sample both a strong and a weak case and make comparisons across these contrasting cases [17,45]. Our small dataset also allows for the examination of variables of the SES framework in some detail. Poteete *et al.* ([68] p. 33) argues that “close examination of individual cases offers opportunities to develop concepts and theory, identify the limits of general relationships and disprove deterministic hypothesis, control for confounding effects through within-case comparisons, and disentangle causal processes”. It is important for us to note that in highlighting potential SES variables which may influence co-management governance outcomes, we do not seek to establish causation. SESs are complex systems with cross-scale and cross-level interactions occurring over time; that, in and of itself, makes it difficult to isolate specific variables and their causal relationship in determining co-management outcomes.

5. Study Site

Currently, more than 70% of Belize’s land territory is under forest cover [69]. This has been largely attributed to a relatively small population (324,000) with low growth rates (2.6% annually) [70]. Since independence in 1981 Belize has, with a few exceptions, seen largely progressive economic development [71]. Growth has been especially noticeable in the tourism and agricultural sectors [72].

About 36% of the land territory and 13% of its marine areas are under some form of protected status making up the national protected (NPAS) areas system of Belize [73] (Figure 2). Under the NPAS, there are 95 protected areas in Belize under various management regimes, 46 of which are co-managed [74]. In terms of total area, NGOs co-manage more than 70% of all protected areas in Belize. Protected areas are managed by three government departments, each responsible for particular sectors; the Fisheries Department is charged with the management of all marine reserves, the National Institute of Culture and History oversees archeological sites, and the Forest Department oversees national parks, forest reserves, nature reserves, and wildlife sanctuaries. A consortium of NGOs and CBOs involved in co-management together comprise the Association of Protected Areas Management Organizations (APAMO). Government agencies and the co-managers agency network (APAMO) combine to form the National Protected Areas Technical Committee to create a collaborative system level platform for co-management in Belize.

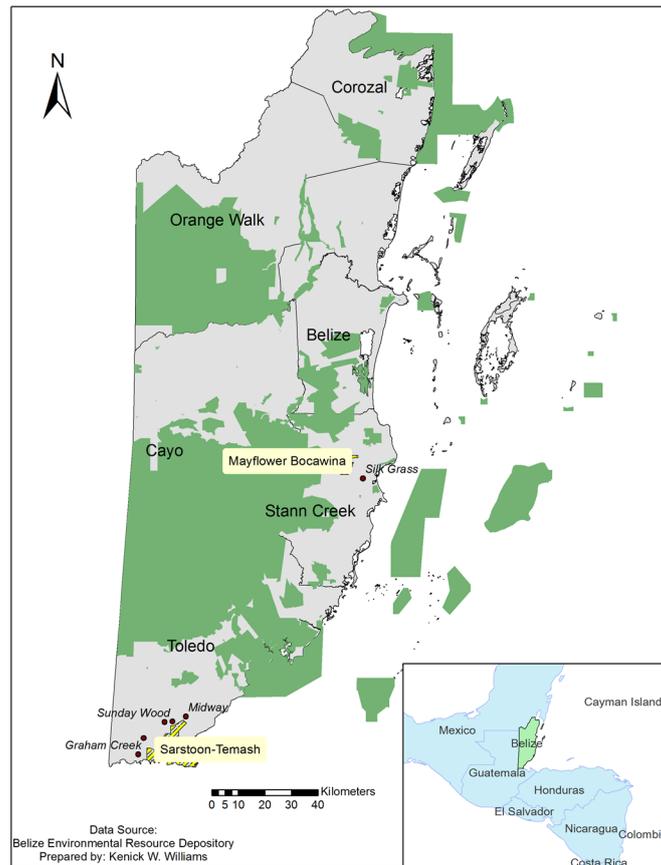


Figure 2. Map highlighting two study sites in Belize, Mayflower Bocawina and Sarstoon Temash. Source: author construction.

5.1. The Sarstoon Temash SES

In 1994 the Forest Department established the Sarstoon Temash National Park (STNP) in the Sarstoon Temash region (Figure 2). STNP is one of the largest protected areas in Belize with a size of roughly 16,938 hectares [74]. Initially, villagers viewed this move by the government as an act to confiscate customary lands since the park was established without consultation or concern for the local people [75]. In 1997, a few years after the park was established, local village leaders in neighboring villages began to organize and hold discussions on how their communities could play an active role in the management of the protected area. The five villages immediately bordering the STNP formed an *ad hoc* committee, the Sarstoon Temash National Park Steering Committee [76,77]. The Committee was led by a local resident who had previously managed World Bank-funded projects.

In 1999, the Committee formally established an NGO, the Sarstoon Temash Institute of Indigenous Management (SATIIM). The SATIIM was funded initially by a multi-agency grant from the World Bank, the International Fund for Agricultural Development, and the Government of Belize. The SATIIM Board of Directors is comprised of one representative from each of the five villages. Other members of the board include representatives from the Toledo Alcalde Association, the Q'eqchi Council of Belize, the National Garifuna Council, the Toledo Maya Women's Association and the Forest Department—key cross-level agencies working in the Sarstoon Temash region. In 2003, SATIIM formally signed a co-management agreement with the Forest Department to co-manage the STNP [77]. The terms highlighted that both parties entered into an agreement for joint cooperation in the management of the national park. As part of the agreement, the parties jointly formulated management and strategic plans for the protected area within the context of the National Park Systems Act. The government, through the Forest Department, retained responsibility for monitoring and maintaining law enforcement [77,78].

Villages bordering the national park are primarily made up of subsistence farmers practicing milpa (shifting) cultivation. Farming is supplemented by game hunting, fishing, and harvesting of non-timber forest products. Work in the villages, including home construction, village maintenance, and milpa are primarily done by communal labor. The recent construction of roads which access neighboring towns, however, has gradually aided in transitioning local subsistence economies into cash economies.

Throughout the 11 years of co-management analyzed in our study, strong leadership was consistent in the management of the STNP. One of its founding members and inaugural Executive Director remained at the helm of SATIIM. The young leader had requisite experience in both organizational management and project management. Between 2007 and 2009, SATIIM established a biological connectivity program with partners of neighboring protected areas including Paynes Creek National Park, Aguacaliente Wildlife Sanctuary, and the Golden Stream Corridor in Belize and the Rio Sarstún Multiple Use Area in Guatemala [78]. The program established joint monitoring initiatives, environmental education campaigns, and alternative livelihood programs between these SES. SATIIM also built strong vertical linkages at the national level with APAMO, PACT, and the PACT Foundation for research and conservation programs, as well with the Forest Department, Police Department, Immigration Department, and the Defense Force for monitoring, park management, and the development of alternative community livelihood programs [74,77,78] (See Table S3 for a revision of local and national level organizations present in both cases). At the international level, SATIIM networked with international NGOs for research (UC Berkeley, Turtle Survival Alliance Organization), conservation and park management (World Wildlife Fund, U.S. Aid for International Development, Conservation International), and community development (European Union, World Bank-Global Environmental Facility) [76–78].

Cayetano *et al.* ([76] p. 80) posit that “SATIIM was established because the communities that immediately buffer the Sarstoon Temash National Park were of the opinion that they needed to co-manage the park if they were to derive any benefit from its existence”. As such, SATIIM established community development as one of its primary mandate with a focus to “encourage sustainable agricultural systems and environmentally sound economic alternatives” [76]. In the process of carrying out this mandate, SATIIM has successfully established alternative livelihood programs. Most notable are the construction of guest houses in the 5 adjacent communities of the national park, the establishment of a community-based sustainable forestry management program for local communities to sustainably harvest and sell logwood, and the construction of a processing facility where women of adjacent communities can produce and sell value-added products. In addition, the protected area was zoned into various use and non-use zones including an indigenous-use zone, a conservation zone, a multiple use zone, a special value zone, and an extraction zone to meet the dual goals of conservation while ensuring that local people can sustain local livelihoods [74]. Since 2002, SATIIM has established a Secretariat in the administrative town of Punta Gorda where it centers its operations. They employ five full-time administrative staff and seven field-staff.

Between 2005 and 2014, the Sarstoon Temash SES faced several external threats from oil exploration, illegal logging (particularly of the Honduras Rosewood (*Dalbergia stevensonii*) and Xate palm (*Chamaedorea* spp.)), and cross-border incursions from Guatemala. SATIIM and actors in the Sarstoon Temash SES have self-organized to address these multi-level disturbances. At the national level, SATIIM has continued to challenge the issue of oil exploration and drilling permits in the STNP in the Supreme Court. SATIIM also continuously carries out joint patrols with law enforcement agencies as well as with community residents to curb illegal hunting and logging, as well as monitor activities of the oil company in the national park. As indicated earlier, SATIIM has established bilateral programs with FUNDAECO of Guatemala to develop alternative livelihood programs for citizens of neighboring Guatemalan communities in order to reduce incursions into the protected area.

SATIIM holds a bi-annual general gathering to review progress reports, vote on community representatives to the Board of Directors, and set the strategic direction for the organization, the

protected area, and the larger SES. At the community level, each board member is responsible to relay all discussions to villages for deliberation, discussion, and decision-making at the village level. For purposes of voting or deliberation *alcaldes* (local mayors) will call village meetings as the need arises. If an *alcalde* chooses to make decisions without the consultation of villagers he can be immediately replaced. Such was the fate of an *alcalde* in 2014 that made decisions without first consulting villagers [79].

5.2. The Mayflower Bocawina SES

In 2001 the Government of Belize established the Mayflower Bocawina National Park (MBNP) (Figure 2). MBNP is one of the smaller protected areas in the NPAS with an area of just under 3000 hectares [80]. As in the case of STNP, residents were not consulted as part of the process and only found out about the national park after its establishment. The MBNP was established to protect critical biodiversity in the area due to agricultural and silviculture development, as well as to protect Mayan archeological sites [81]. In 2002, residents of the village bordering the national park, in conjunction with the local Tour Guide Association, the Village Council, and the local women's group collectively organized and lobbied the government to co-manage the protected area. Led by the chairman of the Tour Guide Association, the group established an *ad hoc* committee similar to that of the Sarstoon Temash SES. The committee discussed with local residents and stakeholders about opportunities in the burgeoning tourism industry and the potential benefits in joining co-management. In the same year, the Committee formed an NGO, the Friends of Mayflower Bocawina National Park (FMBNP), through a grant from UNDP Global Environmental Facility's Small Grants Program. The FMBNP was led by an American expat with prior knowledge in project management [82]. Other representatives of the Board of Directors included one representative from the Silk Grass women's group, the Dangriga Tour Guide Association, the Forest Department, as well as the village chairman and four additional residents of the village. In 2003, the Forest Department and the FMBNP signed a memorandum of understanding with the FMBNP to co-manage the MBNP. As with SATIIM, the government devolved rights to the operational management of the park to the FMBNP. The FMBNP, in consultation with the villagers, set the operational strategy for the park. In conjunction with the Forest Department and local stakeholders, FMBNP has established strategic plans for the park but has not devised any management plan to date. The government also divested all the powers of fundraising and fee collection to FMBNP but retained regulatory authority and responsibility for law enforcement in the protected area as per the Protected Areas Systems Act and other legislation. Between 2002 and 2003, the FMBNP acquired funding from international funding agencies to build local stakeholder participation in the protected area. Funding was also leveraged from PACT to carry out a Rapid Ecological Assessment of the park [83]. The newly registered NGO focused on organizing the support of residents, building local capacity in tour-guiding, craft making, and other small enterprises, and in developing the infrastructure of the park to accommodate potential eco-tourism growth.

Diverse ethnicities make up the village including: Mopan Mayas, Creoles, Mestizo, Garifuna, and more recently, Chinese. In the Mayflower Bocawina, few residents depend directly on the protected area for their daily livelihood; small minorities of residents hunt, fish, or harvest forest products as a means to sustain their livelihoods. Some villagers are small farmers who sell produce in the neighboring administrative towns or tourists hubs. A large percentage of villagers are absentee residents working in white-collar jobs in the administrative centers of the country and return to the village only on weekends. Others work at agro-processing facilities in the village.

In 2004, a year after the establishment of the FMBNP, the outgoing migration of many members resulted in dwindling commitments to the NGO. In the process the board lost its founding chairperson. Another member of the board took up the helm but demitted their post a few months later. In 2005, the position was taken up by yet another founding member. The new chairperson, however, did not possess the prerequisite skills in project management as in the case of SATIIM. Currently, that person remains the chairperson while also maintaining a full-time job.

Over time the funding from UNDP dwindled and efforts to leverage additional funding were non-existent. The leader and a few Board members tried to maintain co-management but participation of villagers declined. Participation also declined as the years passed and as socio-economic opportunities did not materialize. Throughout co-management, Mayflower maintained very weak networks locally and internationally. Small funding and technical support was received from PACT at the national level and TREK Force at the international level to maintain the protected area.

At the community level, the village council has not held a village meeting in more than five years, an event largely used by local organizations to update residents on organizational progress. As a result, FMBNP has not held a community meeting in over five years and has not held a Board meeting with quorum in more than five years. According to the Chairperson [84] *“It is very difficult to have all the Board members at one meeting, some people work in Belmopan, Placencia or as far north as Corozal. Currently we only have about four Board members living in the village”*. The NGO is without a secretariat in which to center its operations and employ only two full-time rangers to monitor activities in the protected area. In addition, the Forest Department has been mostly absent in its supporting role to the NGO throughout the 11 years of co-management. The FMBNP has not been able to develop alternative livelihood programs as in the case of Sarstoon Temash SES. After the dwindling participation between 2003 and 2005, no socio-economic programs were established in the village. In addition, the employment of only two wardens to manage the protected area has limited monitoring activities. Wardens are charged with a multiplicity of administrative duties including visitor fee collection, book-keeping, patrolling, and park management. The limited authority and absence of networks with law enforcement agencies has also limited monitoring capabilities to curb illegal activities. *“We know that people are hunting and fishing in the park and we know who they are. We cannot arrest them so we can only ask them not to do it”* noted the lead park warden [85]. A major external disturbance is the encroachment of farmland into the boundaries of the protected area; however, the extent of species loss or habitat destruction is unknown.

6. Results

Co-management, as an alternative to centralized governance of protected areas, is an ongoing process in which outcomes are affected by key activities and interactions at all levels of governance. In the cases explored here, the interplay of different SES variables at various levels seems to have influenced co-management over time. Table 2 provides a snapshot of those variables associated with co-management outcomes at various spatial and temporal levels that were identified in our analysis. We highlight five selected second-tier interaction (I) variables and discuss their interrelationships with contextual variables of actors (A) and governance system (GS).

Table 2. Influential variables in co-management outcomes in Sarstoon Temash and Mayflower SES.

Variables	Working Definition	Sarstoon Temash	Mayflower
Governance System (GS)			
GS1: Government organization			
GS1.1: Government departments †	State run department with public mandate	present-weak	present-weak
GS1.2: Quasi-government organizations †	Combined state and civil society managed agencies	present	absent
GS2: Non-government organizations			
GS2.1: International NGOs †	International registered non-government agencies	present-multiple	present-few
GS2.2: National NGOs †	Nationally registered and operated non-government agencies	present-multiple	absent
GS2.3: Community-based organizations †	Agencies operating at the village level	present-multiple	present-few
GS3: Network structure	Vertical and horizontal partners in co-management	present-strong	present-weak

Table 2. Cont.

Variables	Working Definition	Sarstoon Temash	Mayflower
Actors (A)			
A5: Leadership	Active individual(s) to lead collective action	strong	weak
A6: Social capital A8: Dependence on resources	Degree to which each actor can depend on the other; actors share the same code of ethics and develop levels of trust Dependence on natural system to sustain livelihoods	strong high levels	weak low levels
Interactions (I)			
I2: Information sharing	Forums and media to keep actors abreast of developments	present-high	present-low
I4: Conflict resolution	Forums to address conflicts and reach amenable conclusions	present	absent
I5: Investment activities	Building of human and resource capacity in SES	present-high	present-low
I7: Self-organizing activities	Collective action activities to govern SES	present-strong	present-weak
I8: Networking activities	Liaise with horizontal and vertical partners to foster collective action	present-strong	present-weak
O1: Co-management outcome		Strong	Weak

[†] Suggested additional third-tier variables.

Information Sharing. In Mayflower Bocawina information sharing (I2) was lacking throughout the co-management process. The absence of a fulltime leader (A5) continued throughout the co-management process resulting in limited information sharing among stakeholders. Conversely, bi-annual meetings to inform community residents of the happenings of SATIIM and to select community representatives to serve on the Board of Directors and other standing committees are mandated within SATIIM's bylaws. Village meetings held by *alcaldes* and other local leaders also serve to keep villagers abreast of the happenings in the Sarstoon Temash SES (A6). The presence of a village representative on the Board of SATIIM with a mandate to update villagers after each meeting helps to facilitate information sharing and provide a platform for conflict resolution (I2, I4).

Conflict resolution. In the absence of a village council meeting, the chairperson of FMBNP did not call any special community meeting in more than five years to update residents of the village (I2, I4, and A5). This also meant that there were no forums for conflict resolution. Many residents expressed distrust for the Board of FMBNP and the government. One resident indicated “we don't know what is happening with FMBNP or at the protected area. I don't know what they or the government is doing with the protected area” [86]. In our time in the field, no community meetings were held by either FMBNP or the village. In the Sarstoon Temash SES, residents' first point of addressing conflict is via village meetings held by *alcaldes*. Each village representative presents updates to the community at village meetings. A second forum for residents to address conflicts is community meetings held by SATIIM. In both options meetings are called as the need arises. For example, in the recent conflicts regarding oil exploration and the debate over communal territory, we observed village meetings being called bi-weekly and sometimes weekly between February and July 2014. In these meetings we observed very high levels of participation, negotiation, and discussion. Residents can also address concerns regarding the national park or the management of SATIIM at bi-annual gatherings.

Human Capacity Building (Investment Activities). Government organizations (GS1), including government departments (GS1.1) and quasi-government agencies (GS1.2), failed to deliberately reach out to FMBNP (GS2.3) to provide the requisite capacity building (I5). The Forest Department (GS1.1) offloaded many of its responsibilities to FMBNP and has not aided in monitoring for many years, thus negating its part of the co-management agreement. This is also true for SATIIM; however the presence of community rangers and local monitoring programs established by SATIIM in collaboration with the community has helped to keep illegal activities at bay. On the other hand, multiple reports of illegal

activities in MBNP go unchecked as they lack the resources, capacity, and collaboration to properly monitor and enforce rules. As the funding face of the state, PACT (GS1.2) did not actively reach out to weak initiatives, such as in Mayflower, to strengthen their capacities to access funding through formal grant processes, which may have perpetuated co-management fragility.

APAMO, a bridging organization formed by SATIIM and other strong co-management agencies to strengthen weak initiatives like FMBNP, has bridged this gap by leveraging financial resources from PACT to deliberately target and build capacities of weak initiatives (I5, GS2.2). In the last few years, the leaders and rangers of FMBNP have participated in several short-term courses held by APAMO and the University of Belize's Environment Research Institute including grant writing, strategic planning, protected area management, and fire risk management (I5). The investments of APAMO in Mayflower Bocawina in the last three years have helped to build some capacity in the FMBNP. Mayflower, however, is still weak and requires further investments in human and resource capacities to collectively organize, and build networks necessary to leverage further resources to strengthen co-management.

Investment Activities. Investment activities, particularly in building human capacity, have been historically minimal in Mayflower (I5). Two years after the establishment of the FMBNP, the NGO lost its chairperson. One founding member subsequently took up the mantle as chairperson; however they have been unable to devote requisite time and lacked the resources to build human, financial, and technical capacities (A5, I5). In addition, only a few fragile CBOs and a small number of national and international NGOs are active in the Mayflower Bocawina SES. As such, the community had a small pool of local leaders to draw on to help create a shared vision and lead self-organization, information sharing, and networking. The leadership of SATIIM, on the other hand, was able to leverage funding of more than US\$250,000 from national and international funding agencies annually between 2007–2014 to support community development and protected area management programs [74,78,87] (A5, I5).

Networking. For its part, SATIIM, with the benefit of a strong local leader, has leveraged several grants from PACT through its formal grant process (A5, I8). SATIIM (GS2.3) has also built multi-level and multi-scale networks with several CBOs, national NGOs and international agencies in Belize, the Sarstoon Temash region, and across the world. The presence of several NGOs and CBOs on SATIIM's Board of Directors, for example, has expanded its capacity to network and leverage resources to strengthen co-management of the protected area. These networks have also been vital in the training of staff, local leaders, and villagers, not only in park management but also in areas such as sustainable logging, horticulture, developing value-added products, and other alternative livelihood mechanisms. SATIIM, in collaboration with other local NGOs, has also leveraged funding for scholarships for young people within buffer communities to pursue higher education. In comparison, weak leadership in Mayflower has resulted in poor networking and weak network structures to support co-management (A5, I8). In the 11 years of co-management the leadership of FMBNP only networked with two international organizations, Trek Force and UNDP.

Self-organization. Both co-management initiatives were established as a result of local communities self-organizing and demanding a stake in the management of local protected areas (I7). In Mayflower Bocawina, however, self-organization declined over time. With the constant change of chairpersons in the earlier years of the initiative and later the volunteering of a leader with other responsibilities, the initiative became ineffective (I7, A5). The constant threats from development activities in the Sarstoon Temash SES, such as oil drilling and logging, have engendered pressures on local communities to maintain self-organization to protect community interests. The Executive Director of SATIIM notes that "*Maya people know that their well-being depends on being proactive. We had to create a platform in which we can engage the wider society and protect our traditional way of life*" [88]. Strong leadership and network structure have helped SATIIM to self-organize and build strong collaborative governance institutions.

Resource dependence varies in Sarstoon Temash and Mayflower Bocawina SESs (A8). In Sarstoon Temash, local communities have a high dependence on the natural resources for their daily livelihoods as well as for cultural and religious devotions. These five villages practice subsistence living through which they heavily depend on the SES. The creation of a national park within the Sarstoon Temash

ecosystem, which residents deemed as a possible excise of traditional lands and a threat to livelihoods, served as an important incentive for residents to self-organize not only to join co-management but to ensure its sustainability over time. In Mayflower Bocawina, most people earn a living through wage labor and there is a relatively low dependence on the ecosystem to sustain livelihoods.

In terms of outcomes, co-management in Sarstoon Temash SES has been strong over time which may be attributed to local actors' ability to build strong collaborative networks with other CBOs and NGOs in the Sarstoon Temash SES, international funding agencies and NGOs, and various government and quasi-government organizations in Belize (Figure 3). Throughout co-management SATIIM has built strong networks for power sharing, institution building, knowledge generation, and the sharing of socio-economic benefits to local communities. The Friends of Mayflower Bocawina, on the other hand, has only been able to maintain weak networks with partners in co-management in Mayflower Bocawina SES. Power-sharing, knowledge-generation, and institution-building are weak in the Mayflower Bocawina SES. In addition, local residents receive minimal socioeconomic benefits from the co-management process.

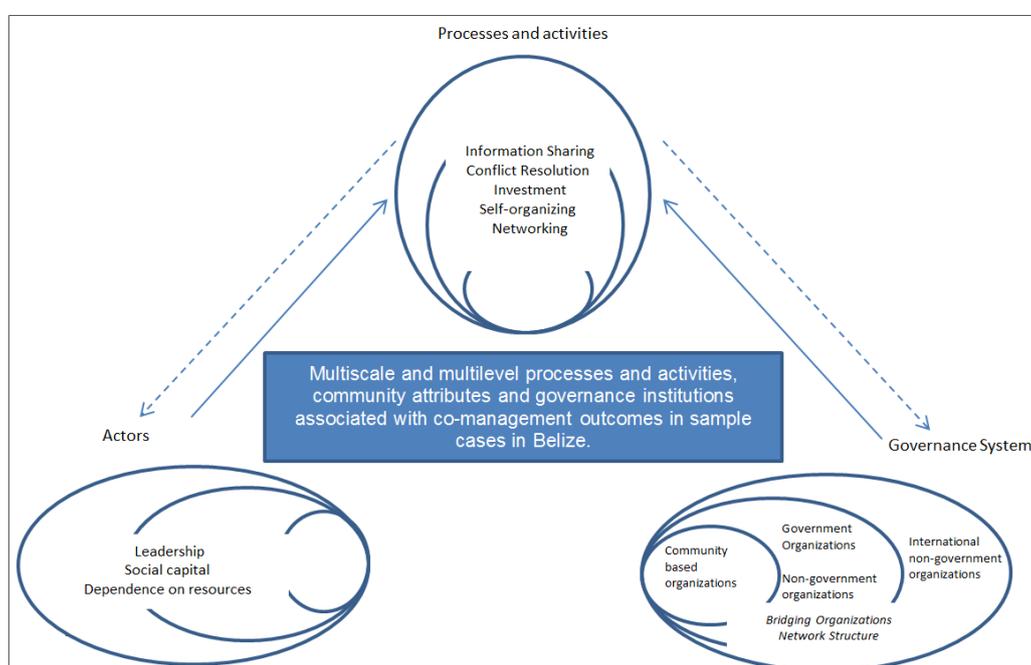


Figure 3. Schematic diagram showing key processes and interactions of the governance system and actor variables that are associated with sample protected areas co-management outcomes. Processes and activities are influenced by community attributes and governance institutions. Semi-ovals represent multiple scales of co-management institutions and processes. Variables appearing across ovals indicate the multi-scale functionality of those variables. Solid arrows represent a direct influence and broken arrows represent feedback.

7. Discussion

We applied Ostrom's multi-tier SES framework [22,23] to carry out a systematic diagnosis of two cases of protected areas co-management in Belize. Existing scholarly literature of potential variables influencing co-management outcomes provided a starting point to utilize the framework [12–14,27,33]. The utility of Ostrom's SES framework allowed us to identify key process and contextual variables and their interactions associated with co-management outcomes. In the process of adapting Ostrom's SES framework, we identified the importance of new third-tier variables not represented in the general framework (Table 2). These variables can help to develop the framework further by building a classification of variables as it relates to co-management. These second and third tier variables

of the SES framework guided our analysis in understanding further why the Sarstoon Temash SES co-management initiative was strong as compared to the weaker Mayflower Bocawina SES. By applying Ostrom's diagnostic framework, we were able to go beyond the functional side of co-management thereby highlighting co-management as a process of self-organization, networking, problem-solving, trust-building, learning, and capacity-building [56]. Unlike traditional analysis, the SES framework allows us to go beyond static reviews of the conditions that may influence strong or weak co-management. As such, we were able to analyze the unfolding of resource use, patterns of interactions, and institutional interplay over time and their influence on protected areas co-management outcomes.

We found key activities and processes variables associated with strong co-management in Sarstoon Temash SES included information sharing (I2), conflict resolution (I4), investment activities (I5), self-organization (I7), and networking, as illustrated in Figure 3. These processes and activities occur at the village, SES, national, and international levels as represented by the nested hierarchy in Figure 3. These interactions, which were associated with SES outcomes, were supported by multi-level governance institutions such as the presence of CBOs, government organizations, and NGOs at the national level, and international NGOs. Governance institutions, such as bridging organizations and network structure operated at multiple levels denoted by their cross-cutting nature in Figure 3. Attributes of actors, such as leadership, social capital, levels of dependence on resources seems to have continuously influenced these processes and activities.

In comparison, processes and activities such as information-sharing, conflict resolution, and networking were lacking throughout the co-management process in Mayflower Bocawina. We speculate that the absence of these processes may have contributed to weak networks, poor institution-building, and the lack of socio-economic benefits for local communities in Mayflower's case. Poor leadership, weak social capital, and low dependence on the resource may have also contributed to the absence of these important processes in co-management. In addition, the lack of strong governance institutions, be it community-based, national NGOs, government departments, or international organizations to step in earlier and strengthen co-management seem to have been a critical intervention that could have avoided such outcomes in Mayflower Bocawina SES.

The presence of a strong, educated, full-time community leader in Sarstoon Temash aided in the construction of cross-scale and cross-level networks through which to leverage national and international support to strengthen the co-management process. A strong leader is required to operate in many capacities to network, lead self-organization, and share information. Our findings highlight two key qualities of leadership in protected areas co-management outcomes: first, the presence of a strong local leader is important for co-management; second, the importance of a fulltime dedicated leader to lead and maintain self-organizing activities and processes can be advantageous in achieving strong co-management.

Information sharing at all levels helps to establish a shared vision and develop a singular purpose in co-management [11]. In Mayflower Bocawina, the lack of information sharing fostered an environment of distrust in the co-management process. Increasing distrust consequently bred conflicts. Weak community attributes including norms and social capital facilitated fragile co-management in Mayflower Bocawina. While several studies have highlighted the role of trust and reciprocity among users in avoiding Hardin's [89] "Tragedy" [5,23,48], our findings highlight the additional importance of trust in the actors at upper level of co-management governance, *i.e.*, NGOs and government.

A continuous lack of communication and the lack of conflict resolution mechanisms deteriorated trust and cohesiveness in the co-management of Mayflower Bocawina. As a result self-organization weakened throughout the co-management period. In this vein, Berkes [56] posits that information-sharing helps to create a unified vision. Self-organization helps to turn that unified vision into action. Olsson *et al.* [5] argue that co-management is an emergent property of self-organization in resource management shifting governance from a top-down to a bottom-up arrangement. In Mayflower Bocawina, the combination of very weak social capital and leadership did not foster

self-organization, the communication of such unified vision, nor networking. On the other hand, social and institutional norms, trust, and leadership in Sarstoon Temash have helped to build and foster self-organization, information-sharing, networking, and other processes that facilitate strong co-management.

The presence of strong networks operating at multiple levels and scales is important in building strong governance in co-management. Multi-level and multi-scalar arrangements in co-management are critical for handling cross-level dynamics and linking organizations [56,90]. Multi-level institutions can bridge knowledge, action, and contexts allowing users to respond to disturbances at relevant scales [52]. SATIIM built strong networks with local level organizations, national level NGOs, and myriad international agencies which seems to have contributed to strong co-management outcomes. Owing to weak leadership, such multi-scalar and multi-level networking was lacking in Mayflower Bocawina. These results are supported by Basurto and Jimenez [17] who found that cross-level linkages with government, international organizations, and local communities fostered strong co-management. In addition, our findings highlight the importance of NGOs in influencing co-management outcomes—a key gap identified by Stevenson and Tissot [12]. International NGOs play a key role in providing funding, capacity building, and technical support to community-based organizations like SATIIM and Mayflower Bocawina. National level NGOs can play a pivotal role in advocacy, capacity-building, technical support, and networking. CBOs can serve as a local vehicle for self-organization, collaboration, information sharing and networking and can represent the interests of local resource users [14].

Bridging organizations, such as APAMO, serve to connect various levels of governance and can help in building capacity, knowledge, trust, collaboration, and conflict resolution [56,90]. Our findings align with those of Basurto and Jimenez [12] who found that the presence of strong technical and leadership capacity were associated with strong co-management. Conversely, limited capacity and resources characterize weak community based protected areas. In both Mayflower Bocawina and Sarstoon Temash, APAMO helped to build the linkages between government organizations, national level agencies, and community organizations to strengthen communication, collaboration, conflict resolution, and other key processes in co-management. At this phase of co-management, APAMO played a key role in helping to build the capacity of fragile co-managing agencies like FMBNP. Our findings highlight the important role of bridging organizations. Bridging organizations, such as APAMO, can play a key role in building capacity and influence protected areas co-management outcomes over time.

Levels of community dependence on local ecosystem for sustaining livelihoods can invariably affect community collective action to co-manage protected areas. High levels of dependence on local natural resources, such as in the case of Sarstoon Temash, can serve as a strong incentive for leaders and elders to self-organize, create opportunities for conflict resolution, built cross-level and cross-scale networks to ensure livelihood sustainability [19,23]. In the case of Mayflower Bocawina however, residents' economic livelihoods are tied to blue collar and white collar jobs and thus have low dependence on the protected area. As such, there may be minimal incentives for elders and leaders in Mayflower to self-organize to join co-management.

Our findings also highlight some flaws in assessments such as the Status of Protected Areas Management Effectiveness in Belize, which only produce a long list of variables affecting co-management outcomes. We draw attention to the importance of considering further the interrelationships between variables associated with protected areas co-management success or fragility. For example, while the roles of government departments are important, other facets of the state such as quasi-government organizations or bridging organizations can also help in building the capacity of fragile initiatives. Trust, a critical variable in co-management success, is important not only within resource users, but also trust of government, CBOs, and local leaders. Information sharing at all levels can also help to avoid conflicts and build trust and reciprocity in co-management. Self-organization can occur when some resource users have entrepreneurial skills and are trusted as local leaders and can also

be fostered when users have an incentive to collectively organize. Further, having a high dependence on local resources for daily livelihoods can serve as a nucleating point for self-organization [25]. It can be seen that leaders can avoid fragility in the co-management process by networking with local and international agencies to build local capacity even in the absence of aid from the government departments or quasi-government organizations.

8. Conclusions

The mere act of protected areas reservation does not itself foster sustainability. Protected areas must be actively managed to embrace change and uncertainty. To manage for sustainability, problems of ecosystem management can be addressed through collaborative mechanisms between state and non-state actors. Co-management can continue to serve as an important mechanism to address increasing anthropogenic threats to natural resources. However, to do so effectively, further understanding is required as to why some initiatives fail while others succeed. We applied Ostrom's multi-tier SES framework [22,23] to carry out a systematic analysis of one strong and one weak case of protected areas co-management in Belize. In our weak case, several key processes and activities, specifically information sharing, conflict resolution, investment activities, self-organizing activities, and networking were lacking throughout co-management and seem to have contributed to it being a weak co-management initiative over time. Weak leadership, social capital, and a low dependence on the MBNP were associated with fragility. The failure of government organizations, both government departments and quasi-government agencies, to perform their role in co-management seems to have facilitated weak co-management in Mayflower Bocawina SES. Where as in our strong case, the strong leadership found in Sarstoon Temash SES seems to have facilitated the building of strong network structures at the local, national, and international level to leverage requisite resources to sustain co-management. The leadership in Mayflower Bocawina SES was not able to follow suit. The intervention of APAMO—a bridging organization—in building the capacity of the leadership in Mayflower Bocawina has contributed to the strengthening of the co-management process in recent years.

In this contribution, we provide a nuanced approach to analyze protected area co-management outcomes. We demonstrate the utility of a systematic framework to go beyond diagnosing only those individual variables or conditions that may partially contribute to the sustainability of strong co-management initiatives themselves, but to consider the interrelationships among these variables operating at multiple spatial and temporal levels and scales. The failure to use a systematic framework and address the interrelationships has been noted as a major flaw in previous studies [18]. This problem could be overcome by conducting case studies with the SES framework as a systematic guide [60]. Diagnosis is one promising area for co-management research and practice and requires carefully conducted case studies across different resource types and geographic areas [56]. Thus, as our study demonstrates, scholars can be guided by a consistent methodology wherein results can be compared across cases.

We highlight the opportunity for scholars to strengthen the theoretical framework further through empirical studies. Our study contributes to the further development of Ostrom's SES framework by proposing the addition of five new third-tier variables: government departments and quasi-government organizations (expanded from the original second-tier variable of government organizations), and international NGOs, national NGOs, and community-based organizations (expanded from the original second-tier variable NGOs). Quasi-government organizations play an important role in supporting and strengthening local co-management initiatives through capacity-building, power-sharing, trust-building, knowledge-generation, and problem-solving [13,56]. International NGOs, nationally-based NGOs, and CBOs play a key role as civil society organizations to bridge functions and processes of co-management between government and local communities [52,90]. This echoes the importance of multi-scale and multi-level governance which can help to build strong networks and linkages in co-management [90].

Our study comes at an opportune time for Belize as the government and co-managers negotiate a revised national co-management framework and subsequent plans to sign new co-management agreements. Such in-depth multi-tier analysis, a first of its kind for Belize, provides a unique look into the state of protected areas co-management at the protected area level. As such, our findings can help to inform both functions and processes of co-management, as well as serve as a guide for future studies to further strengthen co-management policy and practice in Belize.

Based on our findings, we provide some policy recommendations to be undertaken at the site and systems levels to improve protected areas governance in Belize. At the systems level, the Forest Department should clearly delineate its role primarily as a legislative and administrative agency in protected areas governance in Belize. The Forest Department can also work closely with bridging organizations, like APAMO, to improve information sharing at all levels of co-management, build trust in the process, and also strengthen local, regional, and international networks. For its part, to improve co-management outcomes, the Ministry of Natural Resources—the agency with ultimate responsibility for protected areas—should direct PACT to deliberately target fragile co-management initiatives in Belize and provide them requisite funding to invest in capacity building and other site level initiatives. Agencies like APAMO can also continue to play a key role in capacity building in fragile initiatives in the short term with additional financial support from PACT. We caution against the implementation of panacea solutions; each case must be treated uniquely and its history and context carefully considered. The application of the SES framework can address this issue by guiding individual and site level analysis of co-management in Belize to continue to guide practice and improve outcomes.

Supplementary Materials: The following are available online at www.mdpi.com/http://www.mdpi.com/2071-1050/8/2/104/s1, Table S1: Variables posited by the literature as pivotal in influencing co-management outcomes, Table S2: Codes and Sub-codes used in data reduction and analysis, Table S3: Local and National Level Organizations involved in sample cases of co-management in Belize.

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